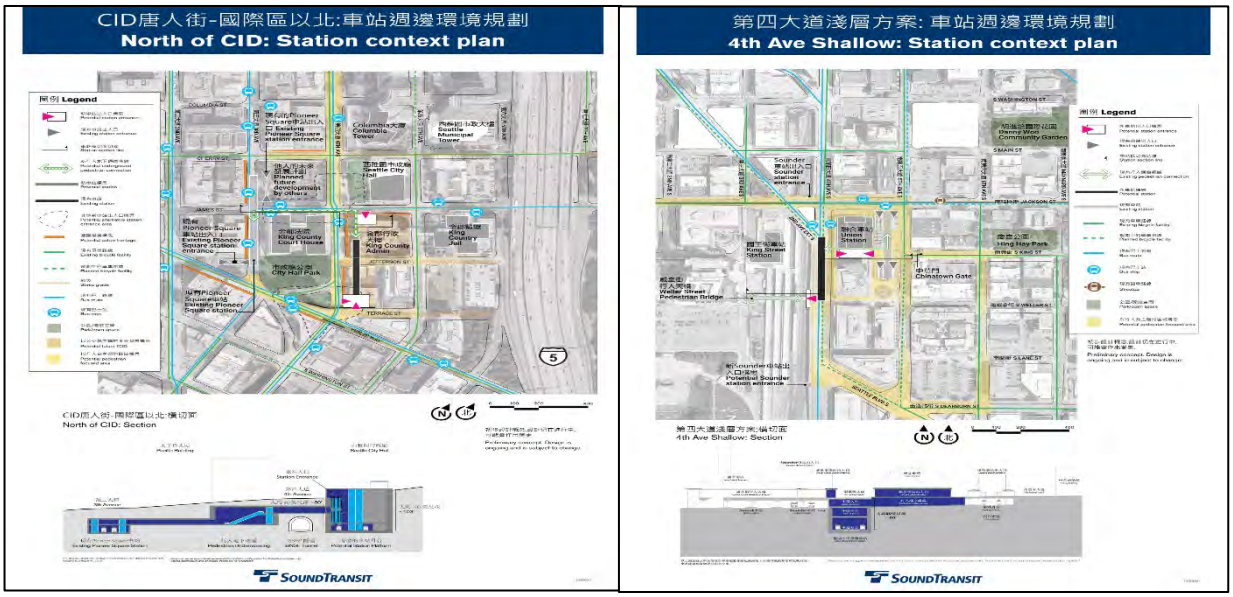
Schedule Analysis Study Report



4th Avenue Shallow Alignment – Schedule Analysis Study

November 17, 2023

Prepared by

Value Management Strategies, Inc.

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APPENDIX A – KEY ISSUE MEMOS

Date: November 17, 2023

To: Rahul Nagalkar
Deputy Director – Value Engineering
Portfolio Services Office (PSO)
Sound Transit

Subject: Schedule Analysis Study Report
4th Avenue Shallow Alignment – Schedule Analysis Study

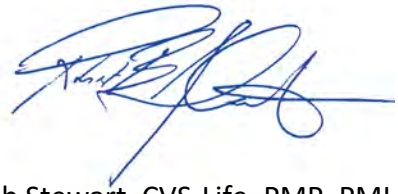
Dear Mr. Nagalkar,

Value Management Strategies, Inc. is pleased to submit the preliminary Schedule Analysis report for the referenced project. This report summarizes the recommendations and proceedings of the workshop conducted August 14 through August 18, 2023, as a virtual meeting session.

Please provide review comments at your convenience and feel free to contact me with questions. I enjoyed working with you on this workshop and look forward to future VE studies together.

Sincerely,

VALUE MANAGEMENT STRATEGIES, INC.



Rob Stewart, CVS-Life, PMP, PMI-RMP, FSAVE
Schedule Analysis Workshop Facilitator

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

A Schedule Analysis (SA) workshop, sponsored by Sound Transit (ST) and facilitated by Value Management Strategies, Inc. (VMS), was conducted to analyze the project schedules and constraints for the potential construction of the 4th Avenue Shallow and North and South of the Chinatown/International District (CID) Alignments.

A virtual workshop was conducted August 14-18, 2023, using the MS Teams® and Miro® virtual meeting platforms. This *Executive Summary* provides an overview of the project, key findings, and options developed by the SA team.

BACKGROUND

This SA workshop was performed to support Board Motion M2023-18, which states the following:

Chinatown/International District

1. *In the CID Segment: The alignment would include a Station North of CID and a Station South of CID.*

   The Board directs further study of the CID 4th Avenue Shallower Alternative as part of ongoing environmental review.

   Additionally, the Board directs further study of the following concepts in the Chinatown/ International District segment as part of ongoing environmental review:

   - *Maximizing connections to all regional/local transit modes comparing the opportunities of the 4th Ave Shallow and 4th Ave Shallower alternatives to the Station North of CID and Station South of CID alternative; and*
   - *Ways to minimize/eliminate construction effects to CID (i.e., truck trips, more carbon-friendly excavation and material disposal methods, etc.) and to significantly reduce the duration of construction.*

WORKSHOP OBJECTIVES

The objective of this workshop was to perform a Schedule Analysis for the 4th Ave. Shallow Alignment, as well as the North and South of CID Alignment, focusing on the following areas:

- Validate current assumptions for the 4th Ave. Shallow Alignment schedule.
- Validate the overall constructability and activity durations of the North and South of CID Alignment schedule.
- Identify ways to minimize/eliminate construction effects to CID and to significantly reduce the duration of construction.

OVERVIEW OF ALIGNMENT ALTERNATIVES STUDIED

The latest version of the 4th Ave. Shallow Alignment alternative is illustrated in Figure 1. The segment begins at the tunnel portal located roughly adjacent to Stadium Station and runs north under 4th Ave. South with a new station located roughly adjacent to the existing International District/Chinatown Station. The alignment for this segment would continue north, eventually merging back onto 5th Ave. with a station at Midtown.

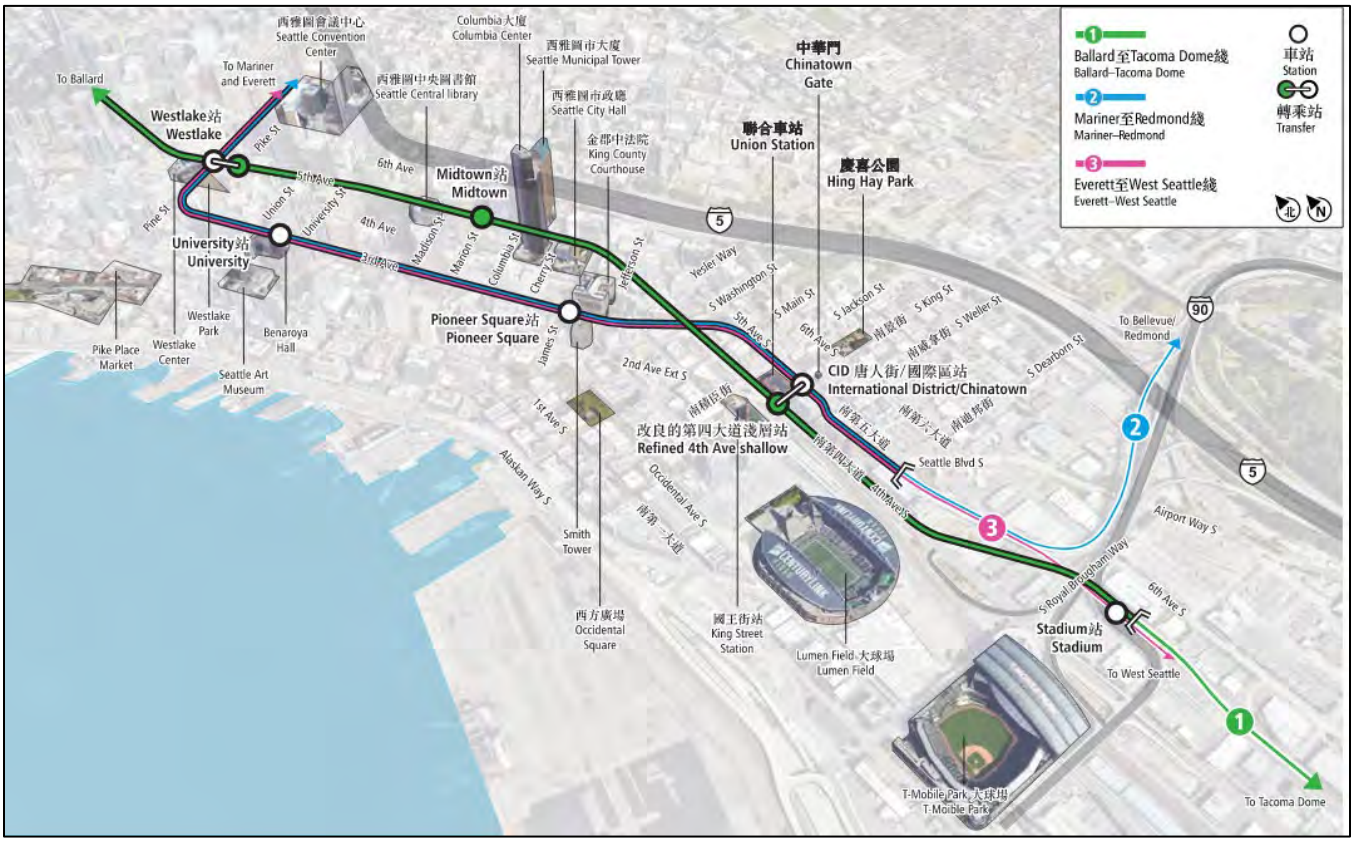


Figure 1 – Refined 4th Ave. Shallow Alignment

Key schedule considerations for the 4th Ave. Shallow Alignment alternative are listed below:

- Twelve years to complete the civil portion of this segment (not including systems, pre-revenue testing, and commissioning).
- Seven to nine years of substantive traffic effects on, and around, 4th Ave. South., 2nd St. Extension, Seattle Blvd., South Jackson St., and Main St.

The latest version of the North and South of CID Alignment is illustrated in Figure 2. The segment begins at the tunnel portal south of Stadium Station and runs north under 6th Ave. South to the South of CID Station located near the intersection of Seattle Blvd. The alignment continues north, tying in at the North of CID Station located east of 4th Ave. in the vicinity of James and Jefferson St.

Key schedule considerations for the North and South of CID Alignment alternative are listed below:

- Seven years to complete the civil portion of this segment (not including systems, pre-revenue testing, and commissioning)
- Four years of full closures on James St. between 3rd and 4th Ave. Six years of full closures on half of Jefferson St. between 4th and 5th Ave. Six years of lane closures along the east curb lane on 4th Ave. between James St. and Terrace St. Five to six years of closure of 6th Ave between S. Royal Brougham Way and Seattle Blvd. (currently closed).

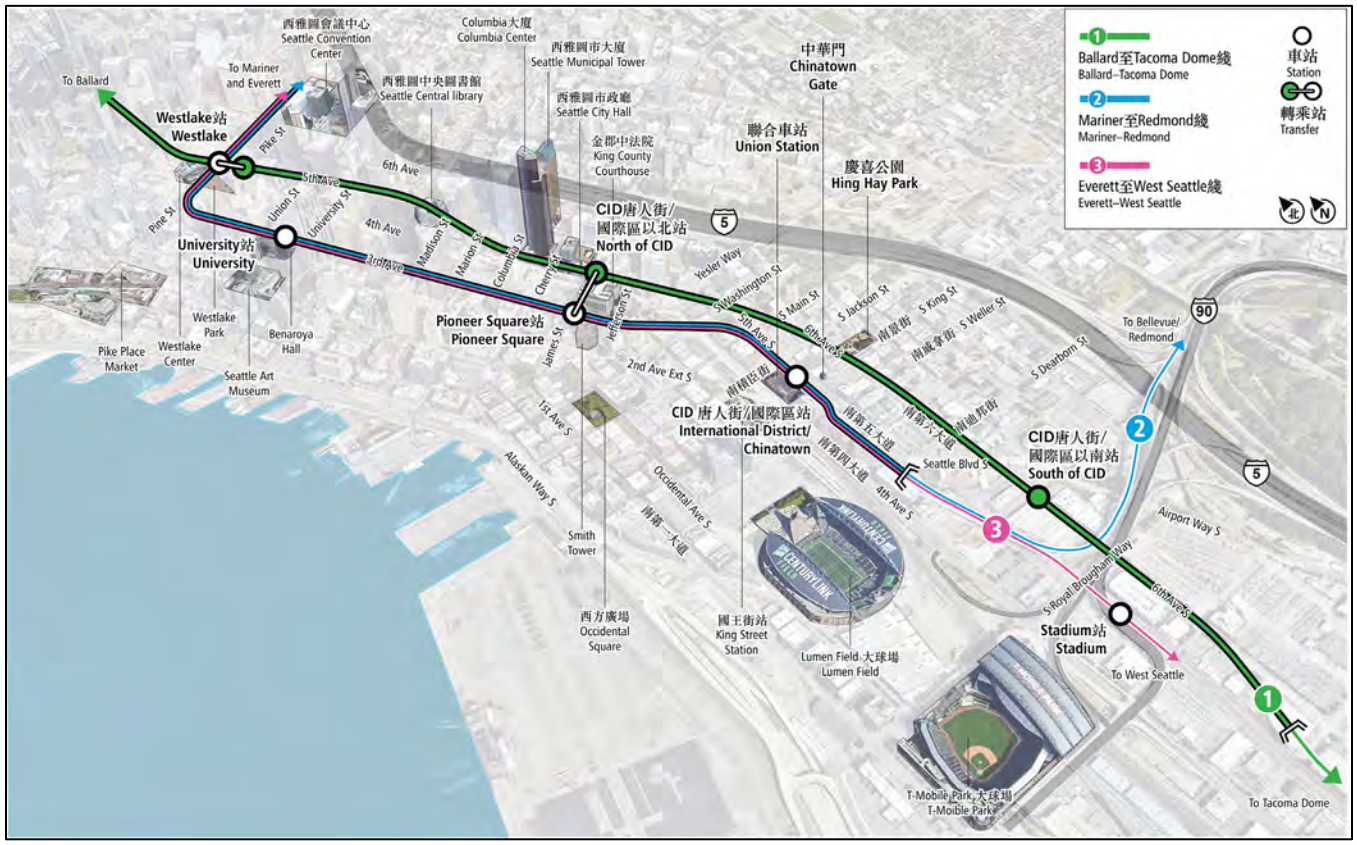


Figure 2 – North and South of CID Alignment (No Midtown Station)

SUMMARY OF FINDINGS

The SA team was requested to address a series of questions related to each of the two alignments. The SA team's responses are provided for each in italics.

4TH AVE. SHALLOW ALIGNMENT

1. **Can you validate the current schedule and assumptions?**

   In general, the overall schedule appears to be reasonable based on the current level of concept development and information available. Several concerns were identified that could increase the schedule and are described further in the Schedule Analysis *section of this report.*

2. **Do you see any opportunities for schedule improvement for either option within defined constraints?**

   Yes, three options were developed by the SA team. Two of these options (Options 1 and 3) work within the existing constraints and could potentially reduce the baseline schedule. Option 1 could reduce substantive traffic effects along South 4th Ave. by about 4 years and reduce the total civil project duration by about 2.5 years. Option 3 could reduce the severity of traffic effects during the total civil project duration by about 5 years. However, these potential schedule benefits may be reduced by the risks related to working adjacent to the active BNSF railroad and removal of the counterfort wall in the vicinity of South 4th Ave. and Seattle Blvd.

3. **What do you see as the greatest construction risks for this option?**

   Construction access is likely to be the most challenging issue facing the 4th Ave. Shallow Alignment alternative which is further exacerbated by the proximity to the BNSF tracks. Additionally, maintaining access to the Union Station Parking Garage is a substantial challenge.

4. **Are there any different construction methods we should consider?**

   Options 1 and 2 offer different staging strategies that could address the risks identified above. Option 3 presents a novel tunnel construction method to further mitigate these risks.

5. **With constraints removed or softened, what else could potentially be considered (e.g. close 4th Ave. fully)?**

   Option 2 developed a hypothetical concept if 4th Ave. South was completely closed to traffic to facilitate construction. This approach could potentially reduce the length of traffic effects to the vicinity of 4th Ave. by 4.5 to 5.5 years (while substantially increasing the severity of the effects) while reducing the project duration by about 3.5 years.

6. **Are there any opportunities for reduction in construction effects particularly in the adjacent neighborhoods?**

   Strategies to reduce effects for the Icon Building were identified. Option 3 has the highest potential to minimize surface effects to the surrounding neighborhood.

Three options were developed by the SA team for the 4th Ave Shallow Alignment that focused on ways to accelerate the project schedule and/or reduce community effects. These are summarized below.

4TH AVE. SHALLOW ALIGNMENT OPTIONS

- 4th Ave. Shallow Alignment – Option 1: Create early construction access by combining multiple stages – East or West side first.
- 4th Ave. Shallow Alignment – Option 2: Close 4th Ave. South and Reconstruct Viaduct in one stage.
- 4th Ave. Shallow Alignment – Option 3: Construct a Pipe Box Tunnel under the 4th Ave. viaduct.

A comparison matrix is provided below summarizing these options relative to the baseline alignment option.

	Baseline 4th Ave. Shallow Alignment	Option 1 Create Early Access by Combining Multiple Stages – East or West side first	Option 2 Close 4th Ave. South and Reconstruct Viaduct in One Stage	Option 3 Construct a Pipe Box Tunnel under the 4th Ave. Viaduct
Civil Construction Duration	• 12 years • *Note: This duration could increase based on risks related to working adjacent to the BNSF tracks.*	• 9.5 years • *Note: This duration could increase based on risks related to working adjacent to the BNSF tracks.*	• 8.5 years • *Note: This duration could increase based on risks related to working adjacent to the BNSF tracks.*	• 7.5 to 8 years • *Note: This duration could increase based on risks related to impacts to the existing 4th Ave. viaduct.*
Traffic Effects	• 4th Ave. Full Closure: Closed from Jackson to Main for 4 years • 4th Ave.: Reduced to two-lanes from Jackson to I-90/Royal Brougham for 5 years • Seattle Blvd. Full Closure: Closed 2 years at 4th Ave. • 2nd. Ave. Extension Full Closure: Closed 2 years • Jackson St. Full Closure: Closed at 4th Ave. for 1 year, 9 months • Main St. Full Closure: Closed at 4th Ave. for 4 years	• 4th Ave. Full Closure: Closed from Jackson to Main for 1 year, 6 months • 4th Ave.: Reduced to two-lanes from Jackson to I-90/Royal Brougham for 3 years • Seattle Blvd. Full Closure: Closed 1 year, 6 months at 4th Ave. • 2nd. Ave. Extension Full Closure: Closed 2 years • Jackson St. Full Closure: Closed at 4th Ave. for 1 year, 9 months • Main St. Full Closure: Closed at 4th Ave. for 2 years, 6 months	• 4th Ave. Full Closure: Closed from Jackson to Main for 2 to 4 years • Seattle Blvd. Full Closure: Closed 2 to 4 years at 4th Ave. • 2nd. Ave. Extension Full Closure: Closed 2 to 4 years at 4th Ave. • Jackson St. Full Closure: Closed at 4th Ave. for 2 years • Main St. Full Closure: Closed at 4th Ave. for 2 to 4 years	• 4th Ave. Partial Closure: Lanes closures at Main St. for 2 years • 4th Ave. Partial Closure: Lanes closures at Seattle Blvd. for 2 years • Main St. Partial Closure: Partial closures at 4th Ave. for 2 years
Challenges	• Highly dependent on MOT phasing. Very little opportunity to re-sequence if delays are encountered • Proximity to BNSF right of way could substantially increase schedule duration due to reduced productivity • Removal of the counterfort retaining wall south of Seattle Blvd. on 4th Ave. South. Could increase schedule duration • Developing access from the Salvation Army Yard to the BNSF track level by the end of Stage 1 is unclear. Could increase schedule duration • Access to the existing Union Station Parking Garage south of Seattle Blvd. appears to be eliminated. Potential to increase cost and schedule duration	• Proximity to BNSF right of way could substantially increase schedule duration due to reduced productivity • Removal of the counterfort retaining wall south of Seattle Blvd. on 4th Ave. South. Could increase schedule duration • Development of access ramps require additional design analysis to validate feasibility	• Proximity to BNSF right of way could substantially increase schedule duration due to reduced productivity • Removal of the counterfort retaining wall south of Seattle Blvd. on 4th Ave. South. Could increase schedule duration • Traffic detours while 4th Ave. is closed for 2-4 years with result in severe effects to regional traffic • Construction approach is aggressive and requires multiple crews working in constricted space. Productivity could vary greatly	• Requires excavation of vertical shafts under existing 4th Ave. viaduct. Constrained work area could reduce productivity • Potential risk that some, or all, of the 4th Ave. viaduct structure may need to be replaced due to construction conflicts or constructability issues • Complicates future replacement of 4th Ave. Viaduct • Installation of the pipe box may cut existing viaduct piles. Potential risk of damaging existing viaduct structure • Involves use of novel construction methods requiring specialized equipment and contractor experience • Possible full closure of 4th Ave. at Seattle Blvd. may could be required to construct jacking pit • Modifies station configuration somewhat

Table 1 – Comparison of 4th Ave. Shallow Alignment Options

NORTH & SOUTH OF CID ALIGNMENT

1. **Can you validate the current schedule and assumptions?**

   In general, the overall schedule seemed reasonable based on the current level of development and the underlying assumptions. A few minor concerns were identified that could increase the schedule and are described further in the Schedule Analysis *section of this report.*

2. **Do you see any opportunities for schedule improvement for either option within defined constraints?**

   The SA team developed two options for the North and South of CID Alignment alternative. Option 1 could reduce the construction schedule by 4-5 months. Option 2 could reduce the construction schedule by 8-9 months.

3. **What do you see as the greatest construction risks for this option? Are there any opportunities for strategies to reduce effects?**

   Construction related to sequential excavation method (SEM) activities for the crossover adjacent to the North of CID Station and obtaining approvals for access shaft needed at either James or Cherry St. were identified as the largest risks by the SA team. These risks, however, are substantially less than those compared with the 4th Ave. Shallow Alignment related to construction adjacent to an active BNSF line.

4. **Any different construction methods we should consider?**

   The use of a triple-cell SEM configuration for the North of CID Station crossover should be considered.

5. **Have we missed anything that would affect duration of North/South?**

   Production rates for SEM may be lower than assumed in the baseline schedule based on past projects.

NORTH AND SOUTH OF CID ALIGNMENT OPTIONS

- North and South of CID Alignment – Option 1: Construct side platforms at North of CID Station and adopt Bellevue Tunnel cross-section for crossover.
- North & South of CID Alignment – Option 2: Construct center platform at North of CID Station with triple-cell SEM approach for crossover.

The table below compares these two options to the baseline North and South of CID Alignment options.

	Baseline North & South of CID Alignment	Option 1 Construct side platforms at North of CID Station and adopt Bellevue Tunnel cross-section for crossover	Option 2 Construct center platform at North of CID Station with triple-cell SEM approach for crossover
Civil Construction Duration	• 7 years	• 6 years and 7 to 8 months	• 6 years and 3 to 4 months
Traffic Effects	• 4 years of full closures on James St. between 3rd and 4th Ave. • 6 years of full closures on half of Jefferson St. between 4th and 5th Ave. • 6 years of lane closures along the east curb lane on 4th Ave. between James St. and Terrace St. • 5 to 6 years of closure of 6th Ave between S. Royal Brougham Way and Seattle Blvd. (currently closed).	• Similar to baseline but potentially a few months less of traffic effects in vicinity of North of CID Station	• Similar to baseline but potentially a half year less of traffic effects in vicinity of North of CID Station
Challenges	• Construction related to sequential excavation method (SEM) activities for the North of CID Station • Production rates for SEM construction could be lower than predicted • Obtaining approvals for the access shaft needed at either James or Cherry St.	• Side platforms are less desirable to support transit operations • Similar SEM challenges to baseline, however, less mining is required	• Similar SEM challenges to baseline, however, less mining is required

Table 2 – Comparison of North & South of CID Alignment Options

SCHEDULE ANALYSIS TEAM

Workshop Team

Name	Organization	Discipline
Bill James	HNTB Corporation	Traffic
Dick Sage	Independent Consultant	Heavy Construction
Dominic Reda	Gall Zeidler Consultants	Tunneling
James Wonneberg	HNTB Corporation	Scheduling
Kelly Burnell	Kleinfelder, Inc.	Bridge
Matt Matsumoto	KBA, Inc.	Heavy Construction
Red Robinson	Shannon & Wilson	Geotechnical
Richard Raine	Independent Consultant	Heavy Construction
Rob Stewart	VMS, Inc.	Workshop Facilitator
Clinton Bevins	VMS, Inc.	Assistant Facilitator

Key Project Contacts

Name	Organization	Title
Rahul Nagalkar	Sound Transit	Deputy Director of Value Engineering
Stephan Mak	Sound Transit	High-Capacity Transit Development Manager
Anthony Pooley	Sound Transit	Principal Construction Manager
Kim Proia	HNTB Corporation	Project Director

SCHEDULE ANALYSIS

The workshop team reviewed the baseline schedules and related assumptions for the 4th Ave. Shallow and the North and South of CID Alignments. This section includes the team's observations and comments related to its review.

4th Avenue Shallow Alignment

In general, the overall schedule appears to be reasonable based on the current level of concept development and information available. The workshop team identified several concerns related to the baseline schedule for the 4th Ave. Shallow Option. These include:

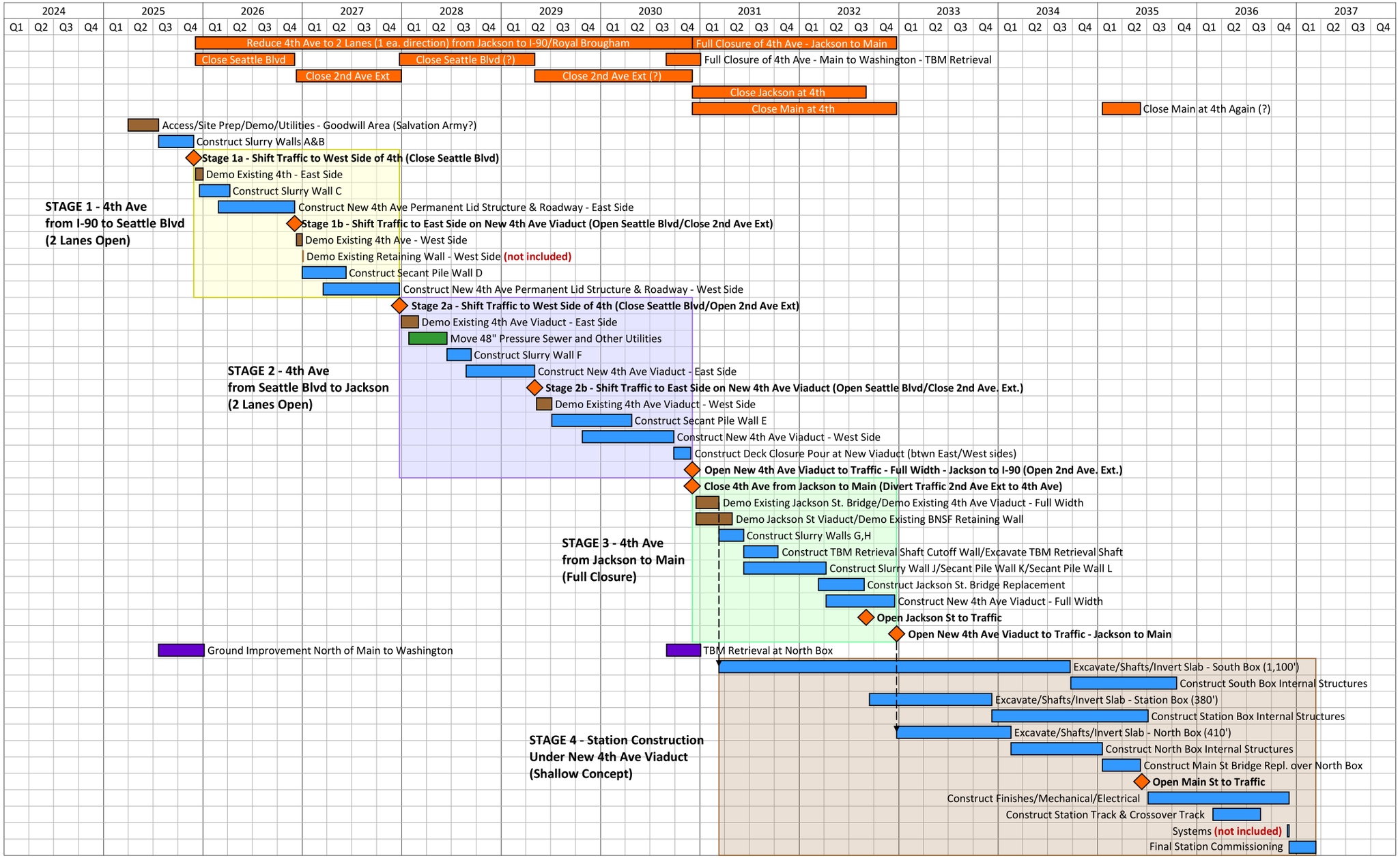
- The duration of wall construction may be optimistic (if Secant Piles are required), particularly those constructed adjacent to the BNSF right-of-way (ROW).
- The duration of demolition activities adjacent to the BNSF ROW will proceed much slower than those on the other side. It is not clear how this is accommodated in the durations.
- The schedule did not include an activity to account for removal of the counterfort retaining wall south of Seattle Blvd. on 4th Ave. South.
- The workshop team is concerned that the feasibility of developing access from the Salvation Army Yard to the BNSF track level by the end of Stage 1 is unclear. Further analysis is warranted to validate this can be achieved based on the current schedule assumptions.
- Access to the existing Union Station Parking Garage south of Seattle Blvd. appears to be eliminated with the baseline staging plan. This would need to be addressed in some manner. One solution would be to buy the Turner Construction Building, demolish it, and develop temporary access through the empty lot.

The workshop team prepared a simplified version of the CPM schedule developed by Forrest Dill using Graphic Schedule. This is included for reference.

WSBLE 4th Ave CID Station - Shallow Concept - Summary Schedule

Activities and durations based on MPP schedule dated 11-28-22

DRAFT rev 3
JRW 14-Aug-23



GraphicSchedule.com

North and South of CID Alignment

The workshop team reviewed the linear schedule for the North and South of CID Alignment with the project team. In general, the overall schedule seemed reasonable based on the current level of development and the underlying assumptions. The following observations were made by the team:

- Activity durations were based largely on recent, experience on other Sound Transit projects including the Northgate Link Extension.
- TBM production rates were assumed at approximately 250 feet per week which assumed two shifts plus a maintenance shift. These assumptions seem reasonable based on available information.
- It is possible that mucking operations could start from the South CID station which could accelerate the start of cross passage excavation and the subsequent handover to the Station. Another option would be to muck out of one tunnel while starting cross-passage excavation from the other.
- The Northgate Link Extension project excavated two cross passages at a time using ground freezing. This seems to be a valid assumption for this alignment as well.
- There is the potential for the Station Finishes contractor to install a sub-invert (shaped to TBM) to allow the Tunnel Contractor to pull TBMs through stations.
- There is the potential to start mining at the North CID Station 3-4 months earlier if the support of excavation (SOE) work begins earlier.
- Pipe arch canopy durations need to be incorporated into the overall SEM durations.
- SEM work for the North CID Station cross-over would likely occur from only one direction. Project must check assumptions on this activity.
- Further, the workshop team noted that Beacon Hill excavation rates were 0.9 feet a day per tunnel which was 1/4 the size of the one proposed here. This could be a much longer activity.
- It was noted that the current schedule was based on a deeper tunnel for the North and South of CID Alignment. The South CID Station depth moved up from 115 feet to 90 feet and the North CID Station moved from up from 115 feet to 95 feet. This will reduce cuts and shafts activity durations.

LEGEND:

202-201-202
6/16/23 New ROD Date
At Grade
Station
ELEV GUIDEWAY

B200 (Two TBM & Two Contracts) ~~6,900 LF~~ CID

B300 DT-1 - Tunnel Twin Bores ~~12,600 LF Ea~~ - B300 DT-1

CID South | CID North | W Lake | Denny | S Lake Union | Seattle Center

At Grad | Walls | Tunnel - Machine #3 | Station | Station | Station | Station | Station | Station | Tunnel - Machine #1 & 2

FOR DISCUSSION PURPOSES ONLY

FOR DISCUSSION PURPOSES ONLY

2023: 1 — January, February, March, April, May, June, July, August, September, October, November, December

2024: 2 — January, February, March, April, May, June, July, August, September, October, November, December

2025: 3 — January, February, March, April, May, June, July, August, September, October, November, December

2026: 4 — January, February, March, April, May, June, July, August, September, October, November, December

2027: 5 — January, February, March, April, May, June, July, August, September, October, November, December

2028: 6 — January, February, March, April, May, June, July, August, September, October, November, December

2029: 7 — January, February, March, April, May, June, July, August, September, October, November, December

2030: 8 — January, February, March, April, May, June, July, August, September, October, November, December

2031: 9 — January, February, March, April, May, June, July, August, September, October, November, December

2032: 10 — January, February, March, April, May, June, July, August, September, October, November, December

2033: 11 — January, February, March, April, May, June, July, August, September, October, November, December

2034: 12 — January, February, March, April, May, June, July, August, September, October, November, December

2035: 13 — January, February, March, April, May, June, July, August, September, October, November, December

2036: 14 — January, February, March, April, May, June, July, August, September, October, November, December

2037: 15 — January, February, March, April, May, June, July, August, September, October, November, December

2038: 16 — January, February, March, April, May, June, July, August, September, October, November, December

2039: 17 — January, February, March, April, May, June, July, August, September, October, November, December

2040: 18 — January, February, March, April, May, June, July, August, September, October, November, December

Procure DBPM
30% Design
18 Mo
Procure Design-Bid-Build Designer (6 Mo)
Develop DB Bridging Documents (6 Mo)
--- RFQ 3 Months ---
-- Procure Design-Build Contractor (9 Months RFP)
Develop Design
18 Mo
Procure CM
60%
90%
100%
Procure W100 Contrac
Procure Contractor
Contractor Submittals and Permits
Procure W100 Civil Tr
Procure Design-Build Contractor (12 Months RFP)
30 Properties
1 Package
ROW Procurement (30 mo)
95 Properties
2 Packages
ROW Procurement (32 mo)
--- Record of Decision ---
--- Select Design-Builder Contractor ---
--- Start Design - 16 Months ---
--- Start Design - 18 Months ---
60 % Design
Early City Permits (12 Mo)
D/B Permits (12 Mo)
OR
Float
Early Design
Design, Utilities Agency Agreements and City Permits for Utility Relocation
Develop DB Bridging (6 Mo)
B80 Material Procurment
B80 Westlake Utility Relocation
Bldg Permits w/ ROW Acquisition (24 Mo)
D/B Permit (18 Mo)
City Permits (18 mo) needed to start first earth work
--- Start Field Construction ---
Demo (B70 Advance Work)
All Saints & Washington
Advance Work Utility (B60)
Demo KC Admin and Crouley Buidling (B100 Advance Work)
Site Prep
Utility Relocation
Westlake Reduce to Two Lanes
Sitework
Portal SOE 6 m
Exc 6 m
TBM Machine Procurement (16 mo)
TBM Assembly 6 m
SOE 8 m
Seattle Blvd Temp
Exc 9 m
Invert
GT
Temp Deck @ James & Jefferson
Exc 10 m
SOE - Cherry St Shaft
Exc - Cherry St
SEM Pipe Arch and GT (6 Mo)
SEM Pipe Arch and GT (6
SEM X-Over From Station Box (12 Mo)
In/Out
TBM #3 - 1,000'/Month
TBM #4 - 1,000'/Month
2,000'
2,600'
TBM 3 Removal
TBM 4
Mucking to South
Perm Lining
CC Roof w/ Opening
Ret Walls
Internal Conc
Hand Over to B625
CID Stations - Possible GC-CM delivery - B625
Saved 3 months
TBM Arrival Window Early
TBM Arrival Window Late
Headwall
Close Shaft
Finishes
Station System
Special Trackwork
Station/ X Over System
B700 Track System
Track-1,300'/Month
OCS-3,000'/Month
Civil Substantial Completion
South Entrance SOE 5 Walls (max 200'
North Entrance SOE 5 Walls (Max 200' D) 6 m
Tension Piles
Exc 179' Deep w/ 12 layers of Strut 7 m
Exc 173' Deep w/ 12 layers of Strut 7 m
Dewate
Invert
GT 3 m
SEM X-cut 90' 5m
SEM Station Cavern Top Heading 170'
SEM Bench and Invert 170' 7m
Sation Cavern Headwalls 50' 3m
Invert 275'
CIP Tunnel Eyes &
Freeze Tunnel Eyes
Zone 1 SOE East (420') - 8th to 9th Ave 6 m
Zone 2 SOE East (250) - 9th Ave to Denny 4 m
Zone 3 SOE East (270') - Denny to John St 5 m
Temp Deck & King Post & Support Utilities
Phase SOE & Deck @ 9th Ave
Phase SOE & Deck @ Denny
Two Lanes Traffic on Temp Decking
Zone 1 SOE West (460') - 8th to 9th Ave 6 m
Zone 2 SOE West (220') - 9th Ave to Denny
Zone 3 SOE West (580') - Denny to John St 9 m
Temp Deck & Support Utilities
Phase SOE & Deck @ 9th Ave
Phase SOE & Deck @ Denny Way
Zone 1 Ventilation Shaft (200') - SOE Secant
Zone 2 South Entrance Shaft (200') - SOE Secant Piles
Four Lanes Traffic on Temp Decking
Shallow Excavation & Install Top Strut
Zone 1 Conveyor
Zone 2 Conveyor
Zone 3 Conveyor
Excavate to L1 & Support Utilities (15,600 CY)
Excavate to L1 (20') & Support Utilities (22,600 CY)
Temp Strut to L1
Excavate to L2 & Support Utilities (15,600 CY)
Excavate to L2 & Support Utilities
Combined Sewer
Temp Strut to L2
Excavate to L3 (15,600 CY)
Excavate to L3
Temp Strut to L3
Excavate to L4 (15,600 CY)
Excavate to L4 (22,600 CY)
Temp Strut to L4
Excavate to L5 (15,600 CY)
Excavate to L5
Temp Strut to L5
Excavate to Invert (19,500 CY)
Excavate to Invert (28,250 CY)
Str. Rat Slab
Backfill to Perm Invert
Freeze Tunnel Eyes
Zone 1 Ventilation Shaft Excavation (120') - In Vertical Sequence with Station Bulk Excavation
Zone 2 South Entrance Shaft Excavation (120') - In Vertical Sequence with Station Bulk Excavation
Mob Slurry Wall
Dexter Lane Reduction
East Entrance Secant Pile Wall West 200'
East Half Slurry Wall 300' 4 m
Dexter Traffic Shift
East Half Sta Slurry Wall 150' 2 m
East Entrance SPW 100'
7th Ave Lane Reduction
King Post
Dexter Temp Deck
West Half Station Slurry Wall 400' 4 m
7th Ave Entrance Secant Shaft West
7th Ave Traffic Shift
7th Ave Entrance Secant Shaft East
West Half Station Slurry Wall 400' 4m
7th Ave Temp Deck
Exc Sta Box & East Entrance
9m
Exc Station West and West Entrance
10 m
Temp Invert
SOE 11 m
Exc 5 m
Ground Treatment
Exc 3 m
Invert
SOE 6 m
Exc 6 m
Slope Stabilization
TBM Machine Procurement (16 mo)
TBM Assembly 6 m
Float
2,000'
TBM #4 - 1,000'/Month
TBM #3 - 1,000'/Month
2,600'
TBM #1 - 1,000'/Month
TBM #2 - 1,000'/Month
TBM #2
Mucking to South
Mucking to North Portal
Cross Conveyor S Lake Union
Cross Conveyor Westlake
Cross Passage
Invert T1
Invert T2
Int Conc
Stations - Possible GC-CM delivery - B650
Track-1,300'/Month
OCS-3,000'/Month
Train Control/ Communications- 2,000'/Month
Systems Substantial Completion
Level 4 Pre-Revenue Testing & Commissioning (6 Months)
ST Control Float - 6 Months
Begin Revenue Service
FOR DISCUSSION PURPOSES ONLY

OPTION 1

Create early access by combining multiple stages – east or west side first

Overview: This option would maintain two lanes of traffic on 4th Ave. while attempting to achieve schedule savings by creating additional/different construction access points for the viaduct reconstruction so that multiple portions can occur simultaneously. Two variations of this option were developed: one that would construct the east side of 4th Ave. first and the other that would construct the west side first.

The access points that could be developed include:

- Seattle Blvd Ramp Access: Create a ramp by taking on half of the Seattle Blvd. structure from ramp down to ground level. This provides access to the viaduct without relying on excavation from Salvation Army Yard. For the ramp shown on page 17 of the report, a more detailed investigation of the physical layout of the deck beams and walls underneath Seattle Blvd. needs to be made. However, it appears that the ramp can be installed without impacting the existing light rail system. Access by "oversized" trucks needs to be evaluated with the proposed ramp as the south entrance is the only access for these trucks.
- Main St Ramp Access: Create ramp at the north end by removing the west side of 4th between Main and Jackson. The ramp will likely be created on falsework. This ramp provides access to the north end of the viaduct and creates an 'exit' for vehicles coming from the south so that construction traffic can run through the project site. No turn arounds are needed.
- BNSF Access Yard Access: Create access around the southwest end of area by utilizing the BNSF auxiliary yard space and creating an opening when the 4th Ave. Counterfort wall is removed. This access requires a temporary construction easement of a portion of the BNSF ROW. This portion of the ROW is currently not being used and is blocked off from the tracks with large concrete blocks.
- 4th Ave. Ramp Access south of Seattle Blvd.: This is the baseline approach concept that is currently part of Stage 1a and is shown in the images included within this Option 1 description. The ramp shown on pages 22, 23 and 24 should have no impact on the Union Station garage or existing LRT. The ramp begins on the north of the southern entrance to the garage (primary access for oversized vehicles and does not come anywhere near the LRT lines. The contractor would need to position a flagger at the top of the ramp for control of construction vehicles and vehicles using the parking garage.
- Additional access from the existing Union Station parking garage into the viaduct construction area can also be created. This can serve as an auxiliary access for most of the smaller vehicles and personnel. It could be opened through the wall toward the north end as to not conflict with the Seattle Blvd. ramp.
- It should be noted that the proposed access points enable multiple headings of concurrent viaduct demolition/reconstruction to compress the schedule. If access from

Seattle Blvd (ramp down) is not feasible, 1 year of proposed schedule savings would be lost. If access from 4th & Main (ramp down) is not feasible, 3 years of proposed schedule savings would be lost. The proposed access from BNSF Aux Yard would be a bonus to the contractor but is not a schedule driver.

Constraints:

- Maintain 4th Ave. (one lane in each direction) between South Jackson St. and the I-90 Ramps.
- The 2nd Ave. Extension and South Jackson St. cannot be closed at the same time.
- Access to one entrance of the Union Station Garage must be maintained at all times. The single garage exit will be right in and right out only to maintain flow on 4th Ave S.
- Demolition of the existing 4th Ave (West side) is shown to be about 1 month long. The demolition of the existing retaining wall along the south end of Seattle Blvd. is not included in the schedule.
- Significant coordination with BNSF needs to be performed to adequately define the constraints under which the contractor must work, which could have a significant impact on the duration of its activities, given the volume of train traffic in this area.

Traffic Effects:

- See attached closure and detour maps for traffic effects.
- It should be noted that the closure exhibit originally identified a 4-year total closure of 4th Ave. between S. Jackson St. and Main St. The workshop team shows 2 years; however, it is noted that this likely optimistic and the closure could extend between 2-4 years to account for additional construction activities likely needed to complete the project in this area.
- There would be periodic lane closures along 4th Ave. for both the baseline and option concepts to support the completion of the 4th Shallow CID Station and access features activities that are not captured in the schedule. These would be comparable for both options.

Staging Concept – East Side of 4th Ave. First:

East Side

- Construction – Stage 1a, Stage 2a, Stage 3a/3b, demolish Seattle Blvd., and build construction access ramp then build construction access ramp at Stage 3a.
- Closure – 4th Ave. S. (One lane in each direction) South of S. Jackson St., Closure of 4th Ave. S. between S. Jackson St. and S. Main St., closure of Seattle Blvd. between 4th Ave. S. and 5th Ave. S., closure of S. Jackson St. at 4th Ave. S., and closure of S. Main St. at 4th Ave. S.

OPTION 1

Create early access by combining multiple stages – east or west side first

- Access – Single access to Union Station Garage must always be maintained through either Stage 1a or 2a. Union Station Garage access will likely require a temporary connection at the south end to maintain access. Access to Union Station Garage via Salvation Army lot and behind Turner Const. Bldg., beneath elevated St. if there is room. Access to Icon Building removed. Icon Bldg. access returned when 3b finished.

West Side

- Construction – Stage 1b and 2b is to maintain construction access ramps at Seattle Blvd. and Stage 3a.
- Closure – 4th Ave. S. (one lane each direction) south of S. Jackson St. *(note: Jackson is open for this work)*, closure to Seattle Blvd., closure to 2nd Ave. extension, and closure of S. Main St. at 4th Ave. S.

Final

- Construction – Remove access ramps and complete work at Seattle Blvd. and Stage 3a.
- Closure – Closure of Seattle Blvd., closure of 2nd Ave. extension, and closure of S. Main St. at 4th Ave.

Schedule Benefits

- Reduces traffic effects on 4th Ave. by roughly 4 years of full closure (3.5 years vs. 7.5 years).
- Reduces project duration by about 1.5 years.
- Opportunities – Closing the Union Station Garage could shorten traffic effects by 1 additional year by starting Stage 1a with Stage 2a.
- The comparison to the baseline design is assuming the same durations.

Staging Concept – West Side First:

West Side

- Construction – Stage 1b, Stage 2b and Stage 3a; build construction access ramps at Stage 3a.
- Closure – 4th Ave. S. (one lane each direction) south of S. Jackson St., Right Turn only at Seattle Blvd. to 4th Ave. S., closure 2nd Ave. extension, and closure of S. Main St. at 4th Ave. S.

East Side

- Construction – Stage 2a and Stage 3b; maintain access ramp at Stage 3a.

OPTION 1

Create early access by combining multiple stages – east or west side first

- Closure – 4th Ave. S. (one lane each direction) South of S. Jackson St., closure of 4th Ave. S. between S. Jackson St. and S. Main St., closure of Seattle Blvd. between 4th Ave. S. and 5th Ave. S., closure of S. Jackson St. at 4th Ave. S., and closure of S. Main St. at 4th Ave. S.
- *Note: Seattle Ave. access happens first along with the Main St. access. It does not take out the east portion of the viaduct but comes in under it.*

Final

- Construction – Stage 1a.
- Closure – 4th Ave. S. (one lane each direction) south of Seattle Blvd.

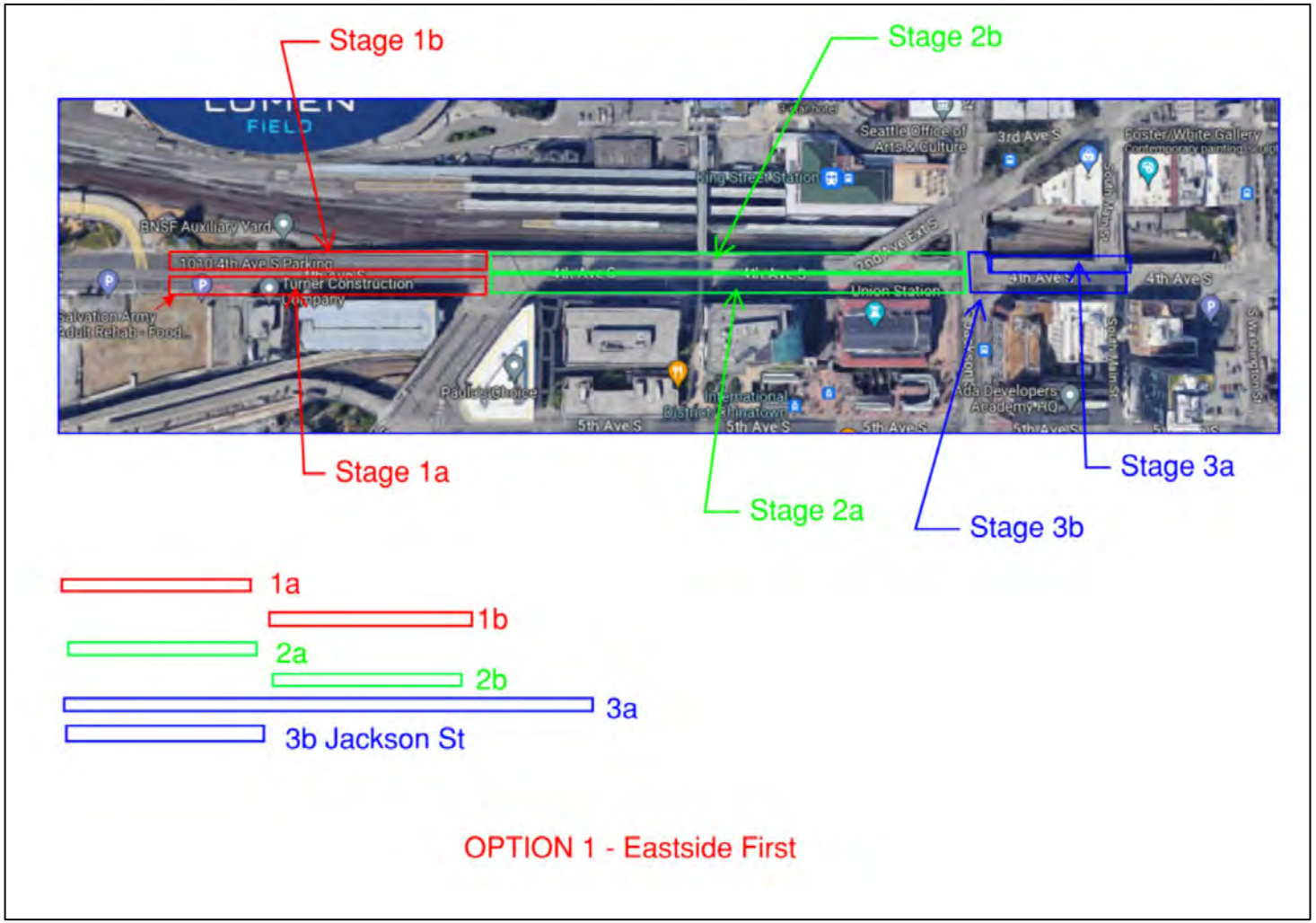
Schedule Benefits

- Reduces traffic effects on 4th Ave. by about 4 years (3.5 years vs. 7.5 years).
- Reduces project duration by about 1.5 years.
- Opportunities – Closing the Union Station Garage could shorten traffic effects by one additional year by starting Stage 1a with Stage 2a.
- The comparison to the baseline design is assuming the same durations.

OPTION 1

Create early access by combining multiple stages – east or west side first

Project Concept Image

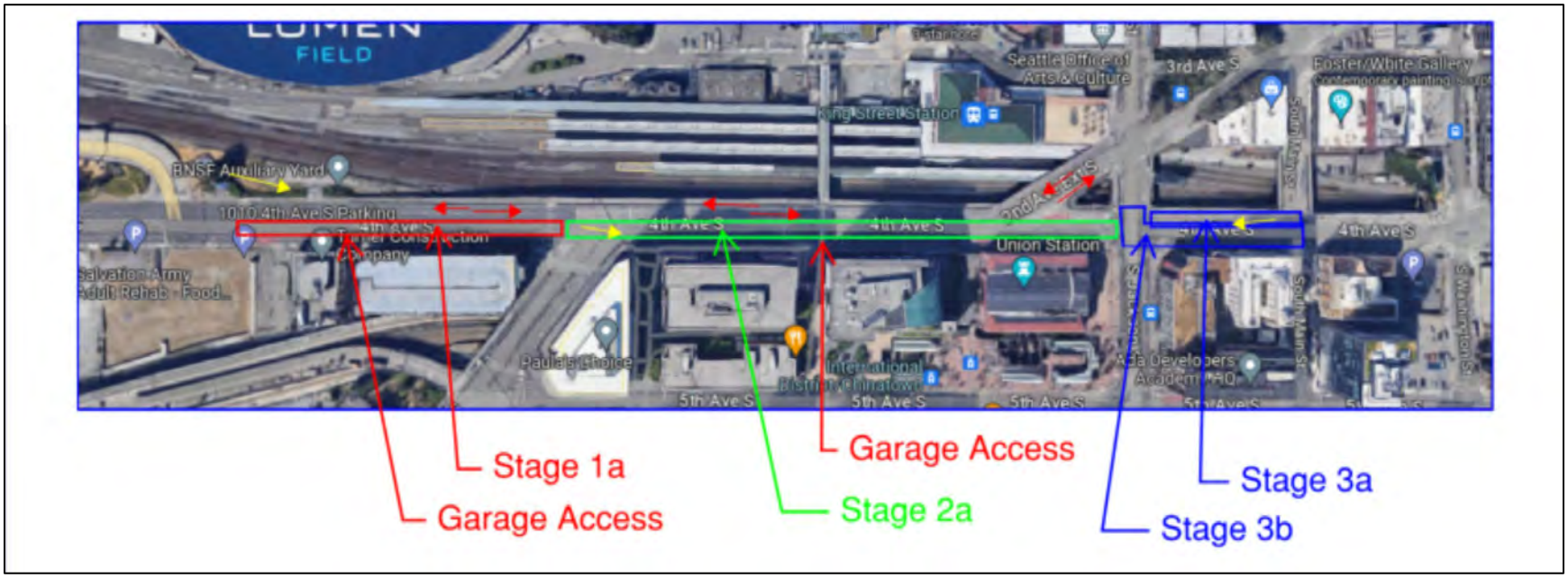


4th Ave. staging Option 1 eastside

OPTION 1

Create early access by combining multiple stages – east or west side first

Project Concept Images

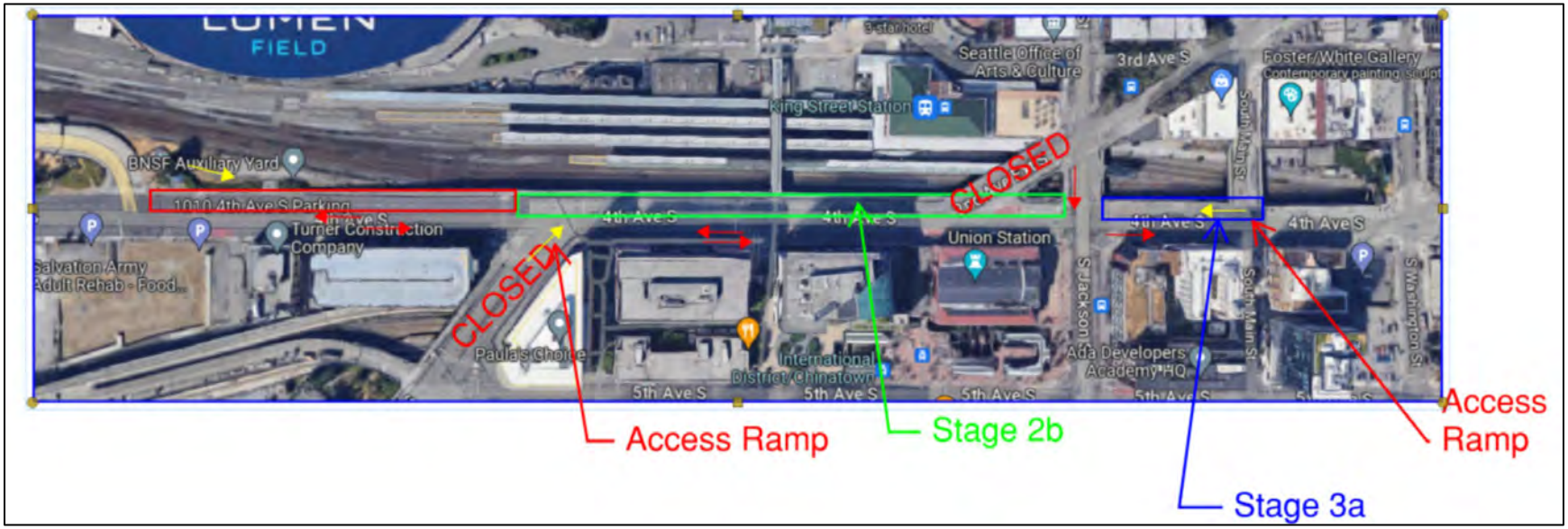


4th Ave. staging eastside diagram alternative view with garage access

OPTION 1

Create early access by combining multiple stages – east or west side first

Project Concept Images



4th Ave. staging eastside diagram with 2nd Ave. exit closed

OPTION 1

Create early access by combining multiple stages – east or west side first

Project Concept Images



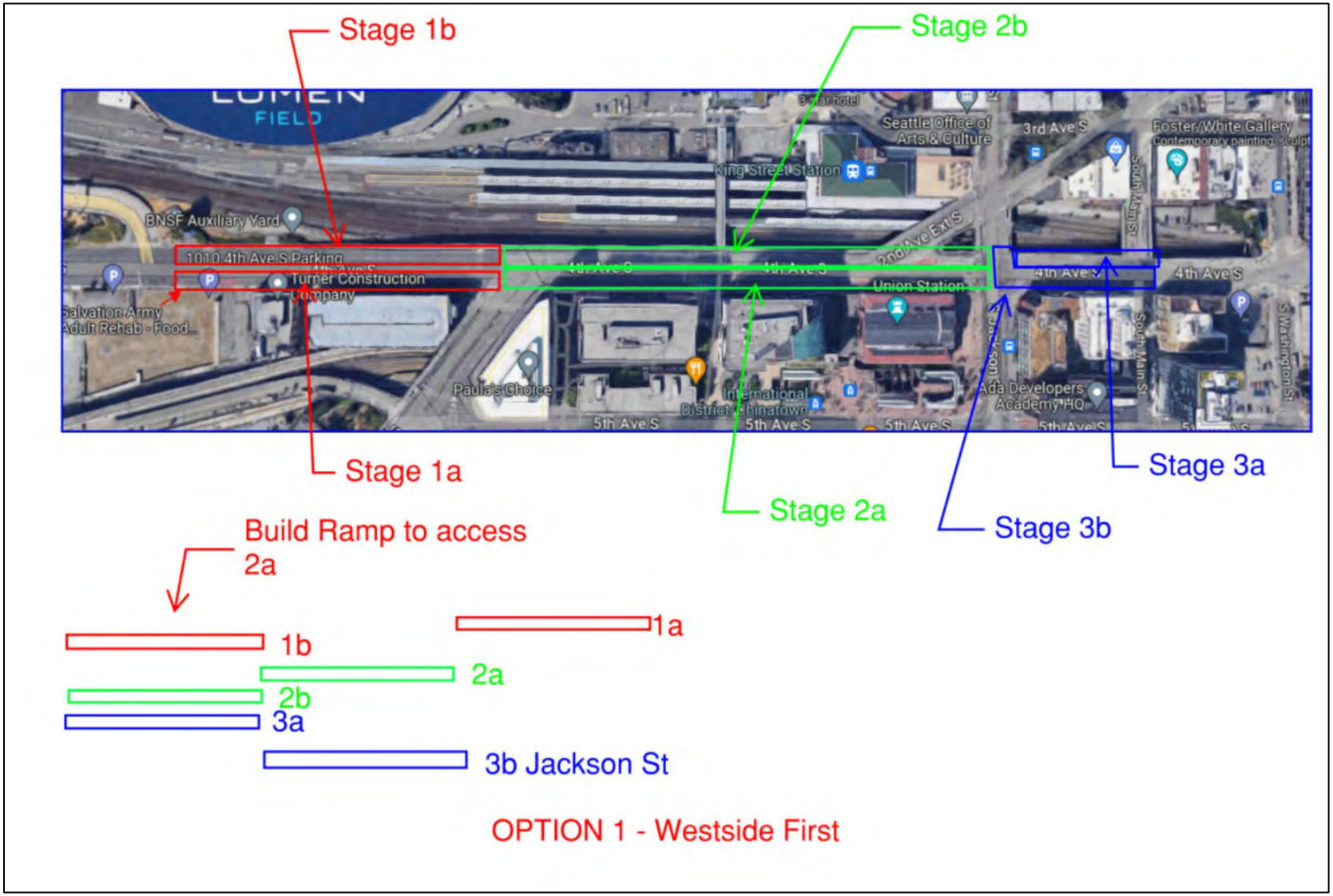
(For the Seattle Blvd access, only half of Seattle Blvd. will be removed, not the whole thing)

Seattle Blvd. access ramp concept with street view and bird's eye

OPTION 1

Create early access by combining multiple stages – east or west side first

Project Concept Images

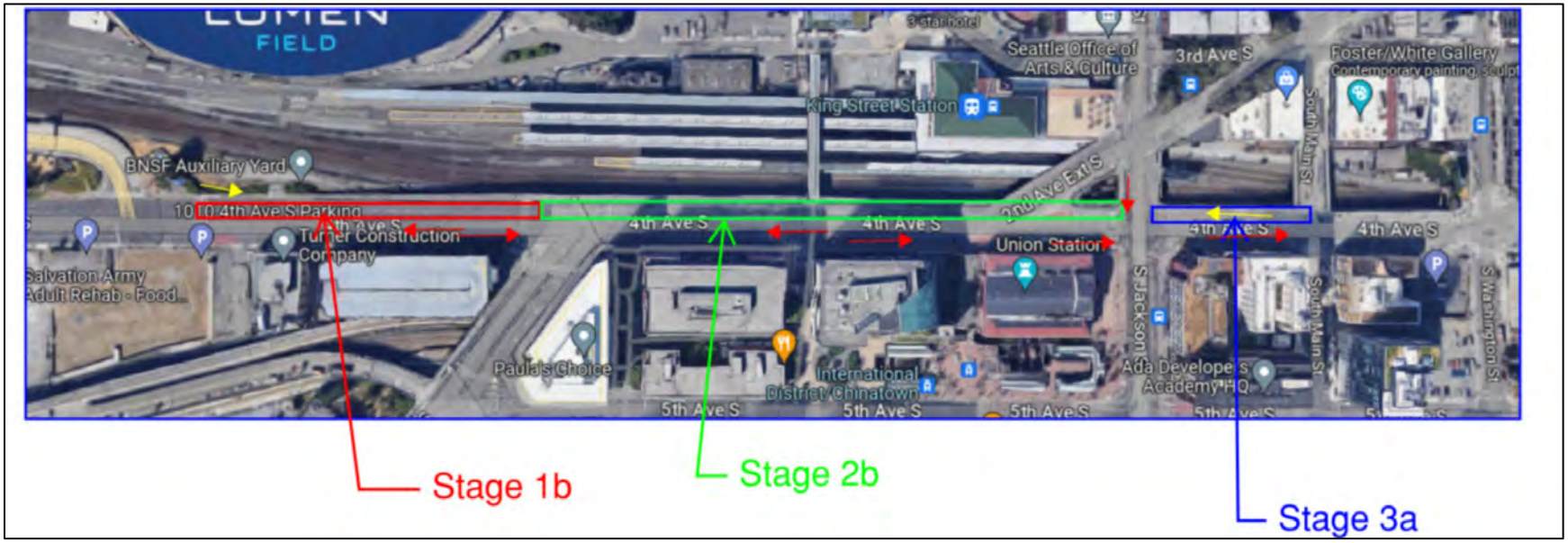


4th Ave. staging diagram Option 1 westside

OPTION 1

Create early access by combining multiple stages – east or west side first

Project Concept Images

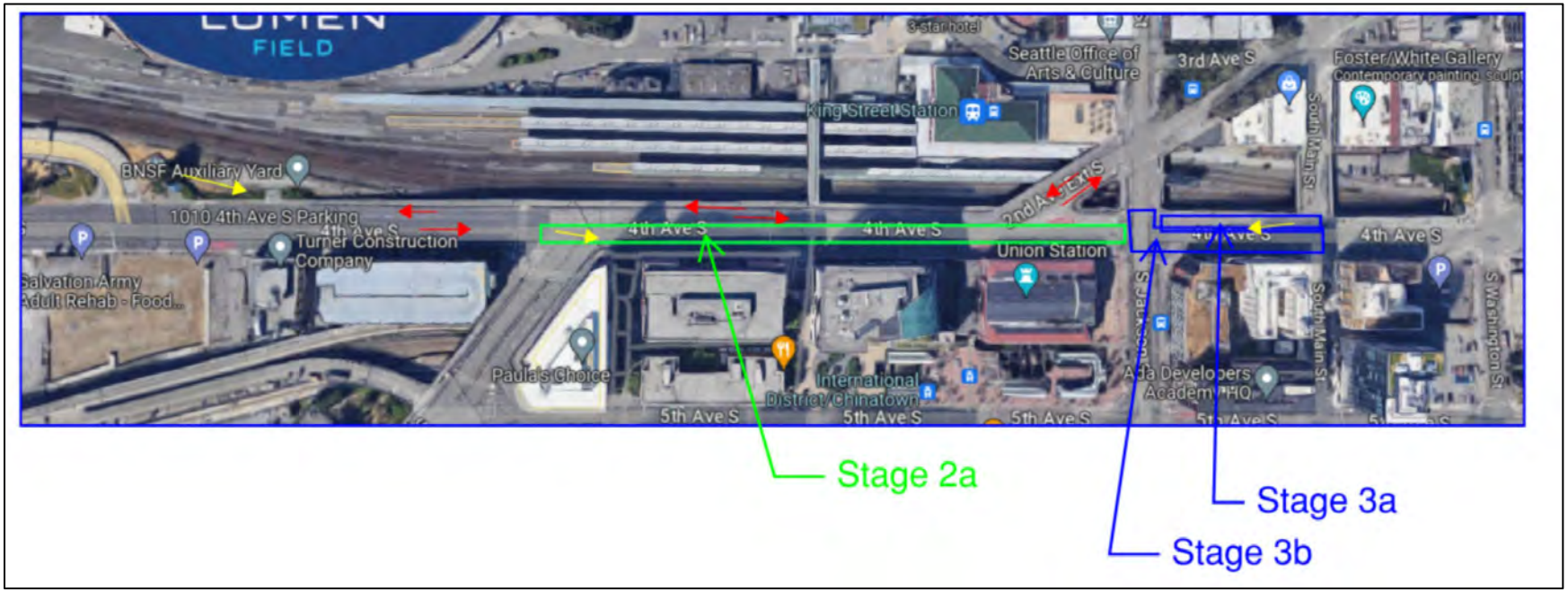


4th Ave. staging diagram westside from 4th Ave. S. perspective – 3a

OPTION 1

Create early access by combining multiple stages – east or west side first

Project Concept Images

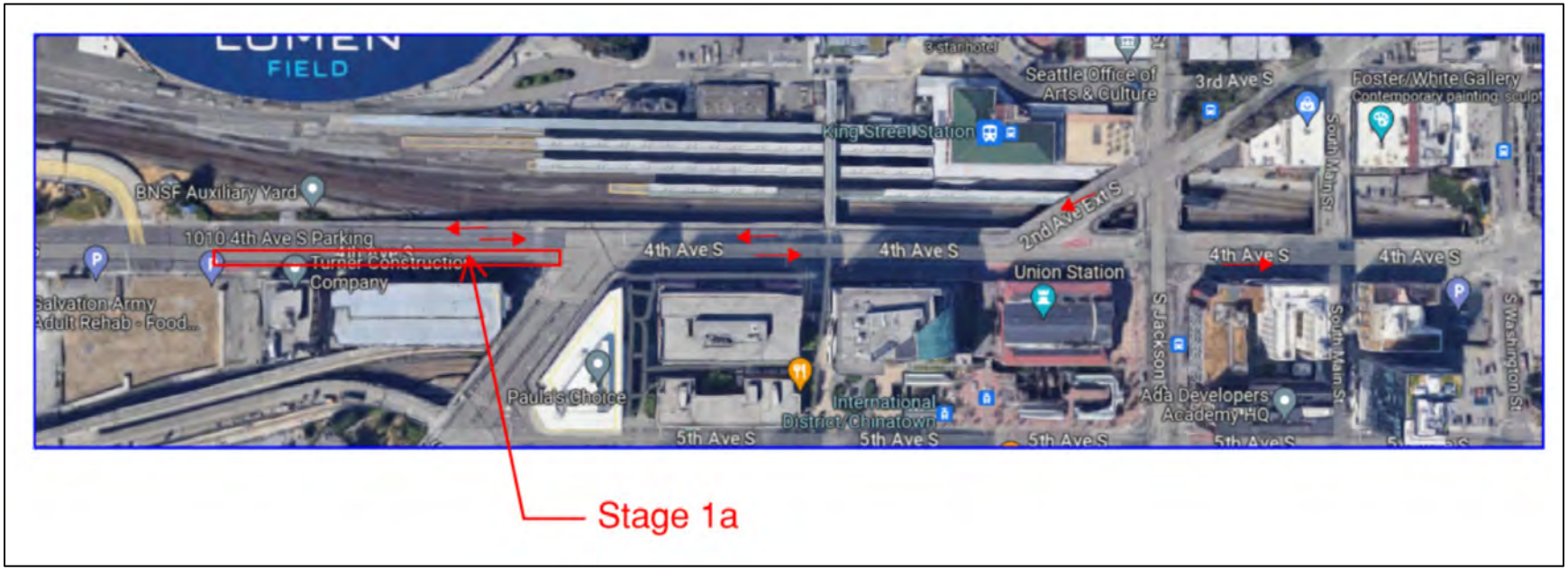


4th Ave. staging diagram westside 3a/3b concurrent

OPTION 1

Create early access by combining multiple stages – east or west side first

Project Concept Images

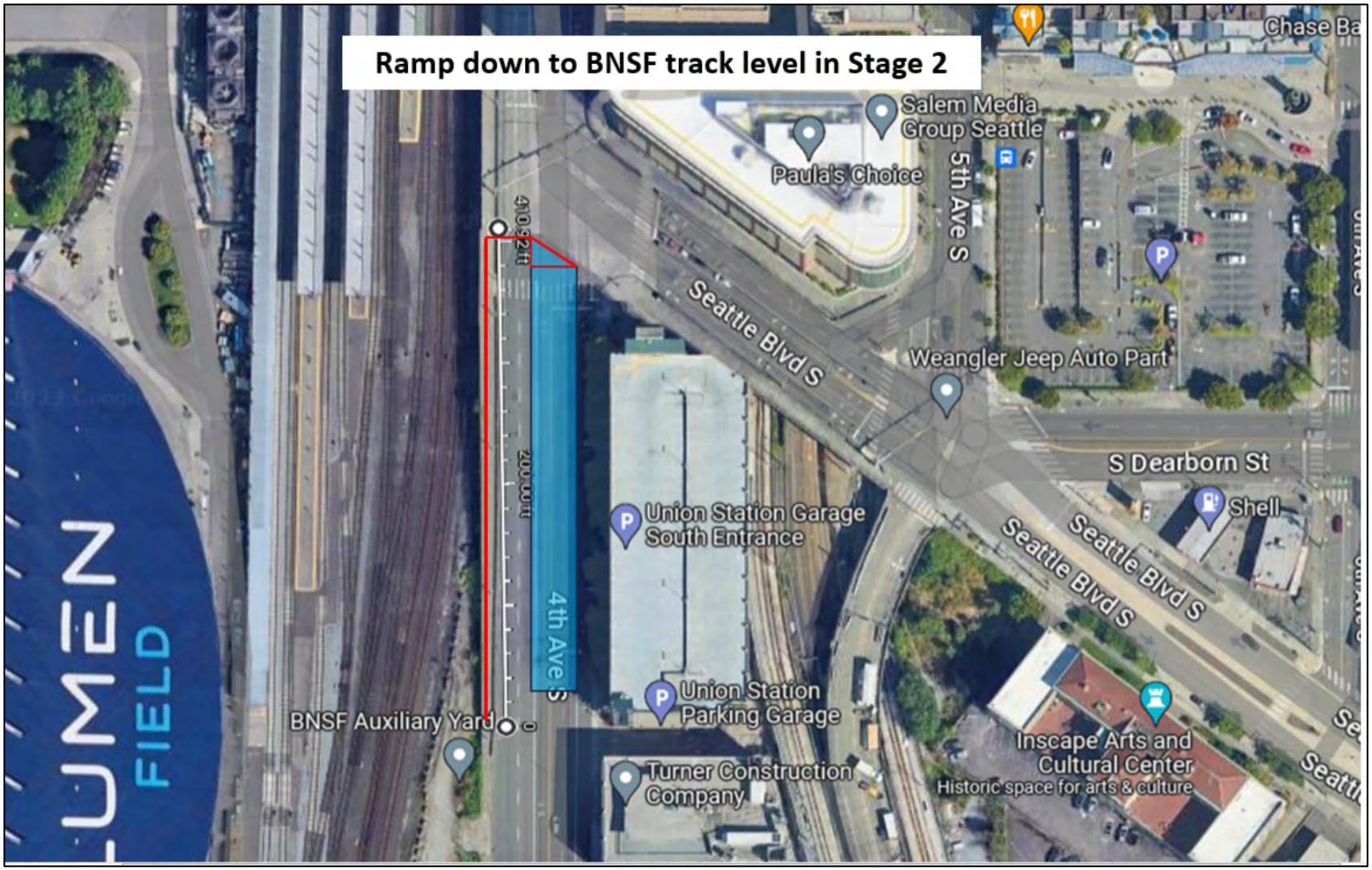


4th Ave. staging westside 1a

OPTION 1

Create early access by combining multiple stages – east or west side first

Project Concept Images

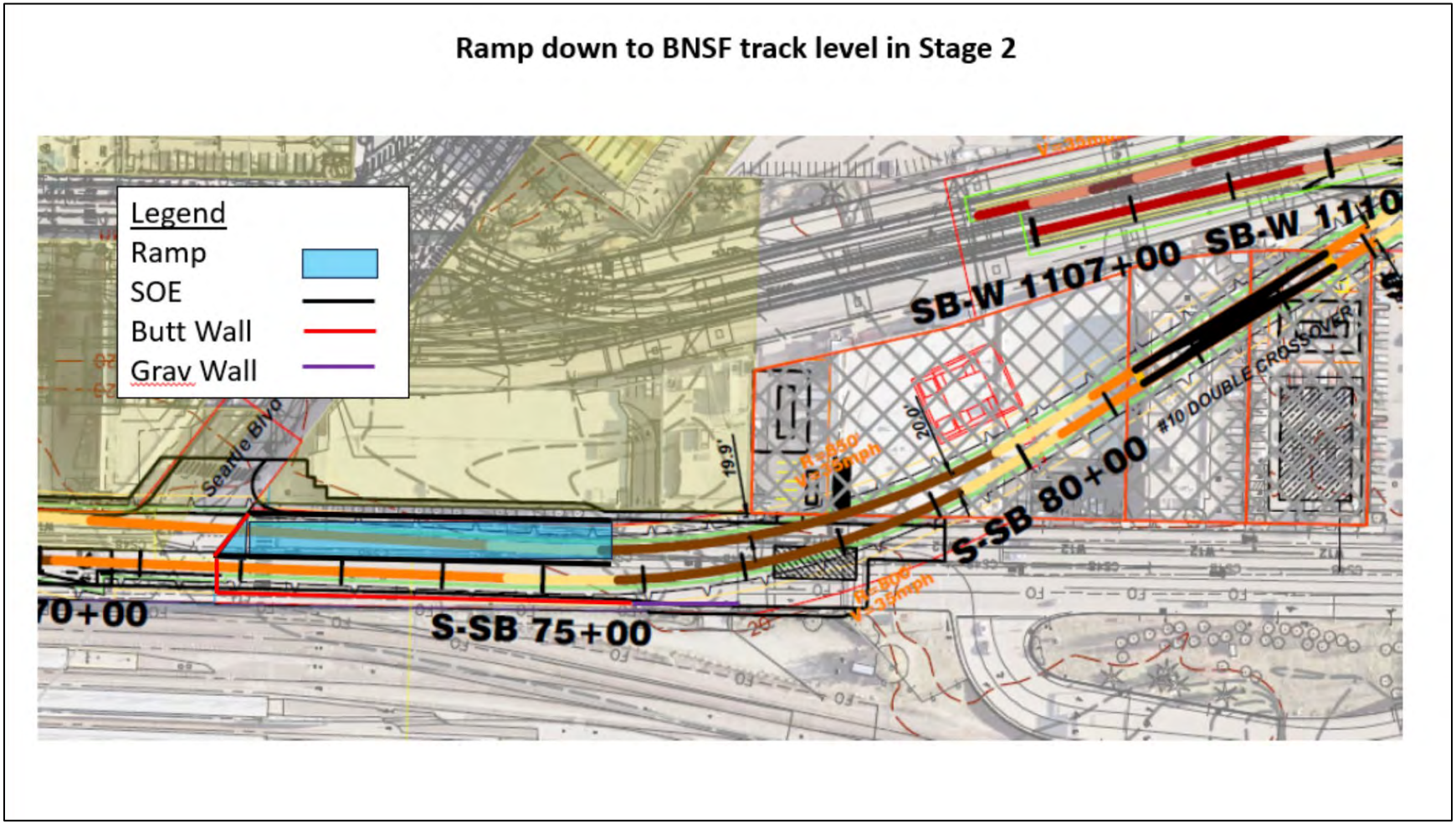


4th Ave. temporary construction access ramp location

OPTION 1

Create early access by combining multiple stages – east or west side first

Project Concept Images

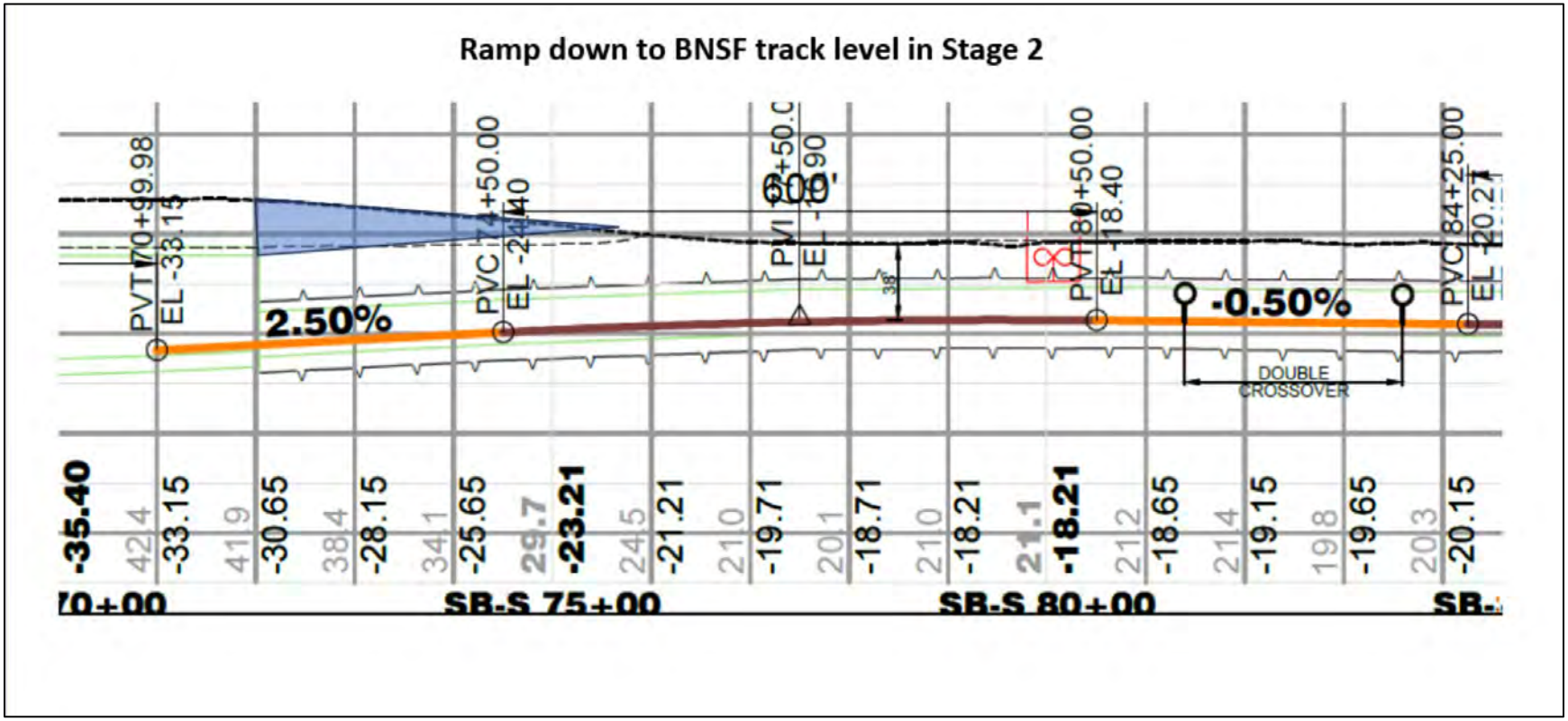


4th Ave. temporary construction access ramp location

OPTION 1

Create early access by combining multiple stages – east or west side first

Project Concept Images

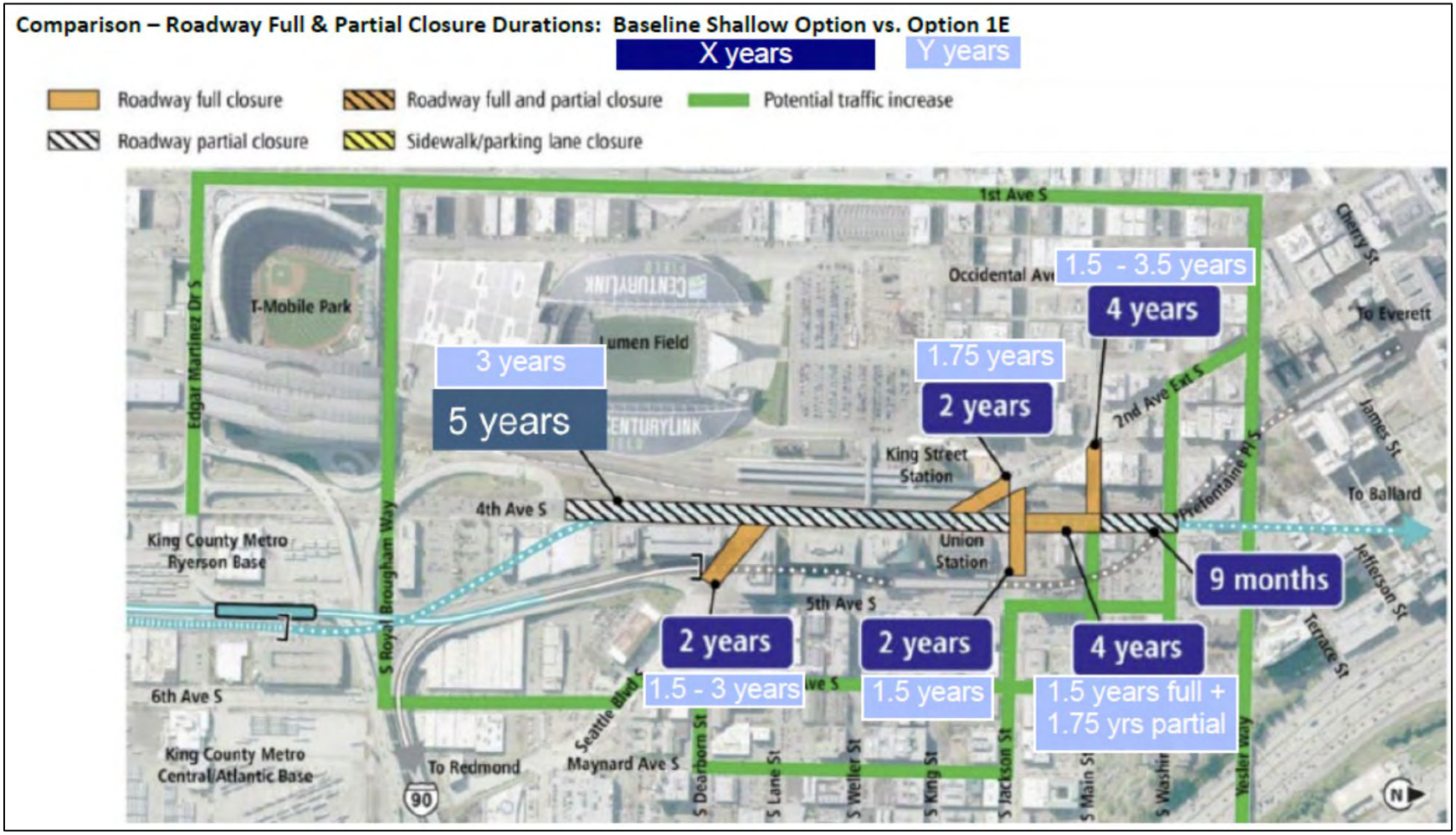


4th Ave. temporary construction access ramp profile

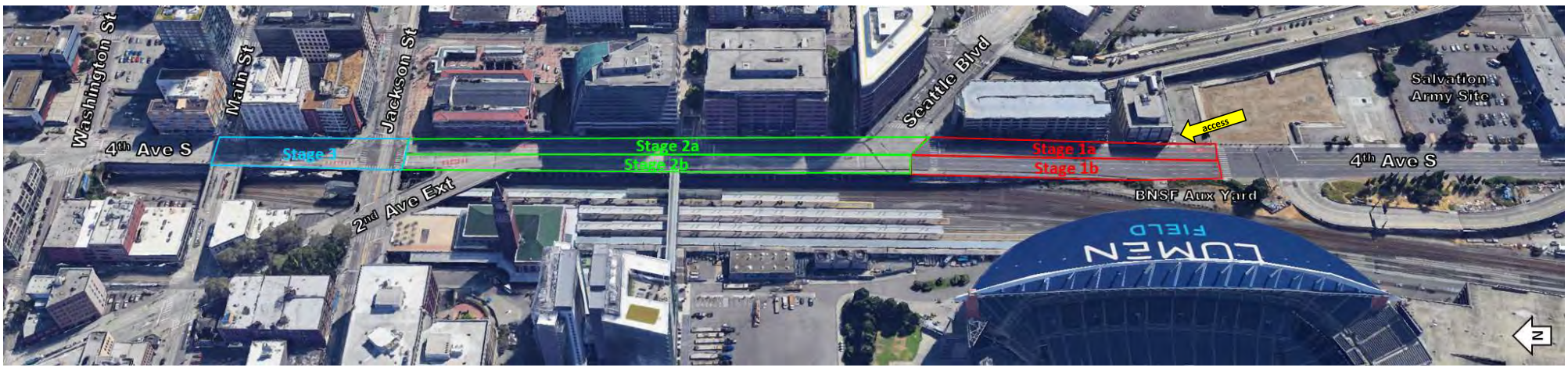
OPTION 1

Create early access by combining multiple stages – east or west side first

Project Concept Images



Traffic closure diagram for Option 1 (east side first) – Dark Blue = Baseline, Light Blue = Option 1 East Side First



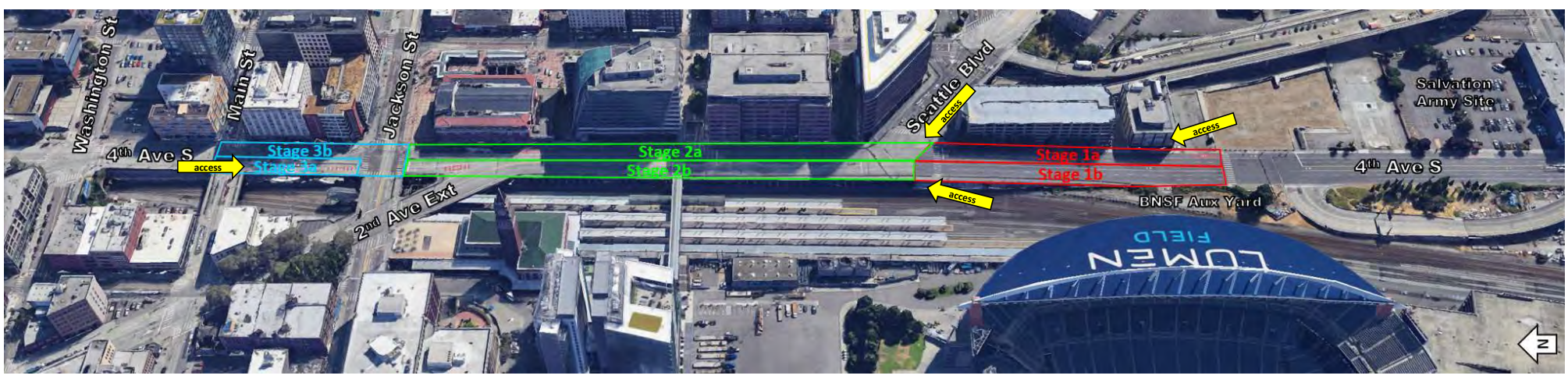
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	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	**BASELINE ASSUMPTION (durations from Nov 2022 conceptual schedule)**																																														
2					**Reduce 4th Ave to 2 Lanes South of Jackson (1 lane each direction)**																																												
3					Access Staging & Slurry Walls - Salvation Army Site																						**Full Closure of 4th Ave - Jackson to Main**																				**Link System Shutdown**			
4					Demo Counterfort Wall at Seattle Blvd (not included)																																											
5					**Shift 4th Ave Traffic to West Side**																																											
6									Stage 1a - Cut & Cover 4th Ave - I-90 to Seattle Blvd - East Side																																										
7									**Shift 4th Ave Traffic to East Side**																																									
8													Stage 1b - Cut & Cover 4th Ave - I-90 to Seattle Blvd - West Side																																								
9													**Shift 4th Ave Traffic to West Side**																																								
10													Stage 2a - Replace 4th Ave Viaduct - Seattle Blvd to Jackson - East Side																																								
11																	**Shift 4th Ave Traffic to East Side**																																		
12																					Stage 2b - Replace 4th Ave Viaduct - Seattle Blvd to Jackson - West Side																														
13																									**Shift 4th Ave Traffic to West Side / Open 2nd Ave Extension / Close Jackson**																												
14																													Stage 3 - Replace 4th Ave Viaduct - Jackson to Main - Full Width																						
15																																	Stage 4 - Construct 4th Shallow CID Station - Under New Viaduct																		
16																																													Systems (not included)			
17																																													Reconstruct Stadium Station in Busway			
18																																													Cutover @ Stadium			
19	**OPTION 1E - EARLY ACCESS TO STAGE 1A, 3B, CONSTRUCT EAST SIDE FIRST**																																														
20	**Full Closure of 4th Ave - Jackson to Main**																																														
21					**Reduce 4th Ave to 2 Lanes (1 lane each direction)**																																												
22					Staging Area & Slurry Walls - Salvation Army Site																																											
23					Break In/Ramp Down from Seattle Blvd thru Counterfort Wall - Access to Stage 1a, 2a																																											
24					**Shift 4th Ave Traffic to West Side**																																											
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26									Stage 2a - Replace 4th Ave Viaduct - Seattle Blvd to Jackson - East Side																																										
27													**Shift 4th Ave Traffic to East Side / Open Jackson / Close 2nd Ave Extension**																																								
28													Stage 2b - Replace 4th Ave Viaduct - Seattle Blvd to Jackson - West Side																																								
29													Demo Counterfort Wall from BNSF Aux Yard - Bonus Access																																								
30																	Stage 1b - Cut & Cover 4th Ave - I-90 to Seattle Blvd - West Side																																		
31					Break In/Ramp Down from Main St in 3a Area - Access to Stage 3b, 2a, 2b																																											
32									Stage 3b - Replace 4th Ave Viaduct - Jackson to Main - East Side + Jackson Intersection (duration equal to Stage 2a - conservative)																																									
33													Remove Ramp in 3a Area																																								
34																	Stage 3a - Replace 4th Ave Viaduct - North of Jackson to Main - West Side (duration equal to Stage 2b - conservative)																																		
35																					Stage 4 - Construct 4th Shallow CID Station - Under New Viaduct																														
36																																													Systems (not included)			
37																																													Reconstruct Stadium Station in Busway			
38																																													Cutover @ Stadium			

CONSTRAINTS
- Maintain 2 lanes on 4th Ave S (one lane ea direction) between Jackson and I-90 ramps.
- 2nd Ave Extension and Jackson cannot be closed at the same time
- Maintain one access to Union Station Garage (may require a temporary structure when traffic is on west side)

BASELINE RISKS
- Need to add time for demo of counterfort wall at Seattle Blvd
- Stages 2b & 3 could take longer than shown due to BNSF restrictions on work adjacent to tracks
- Highly dependent on MOT phasing. Very little opportunity to re-seqence if delays are encountered.

OPTION 1E RISKS
- Stage 2b could take longer than shown due to BNSF restrictions on work adjacent to tracks

OPTION 1E BENEFITS
- Shortens 4th Ave traffic impacts by about 4 years (3.5 years vs 7.5 years)
- Shortens project duration by about 2.5 years.

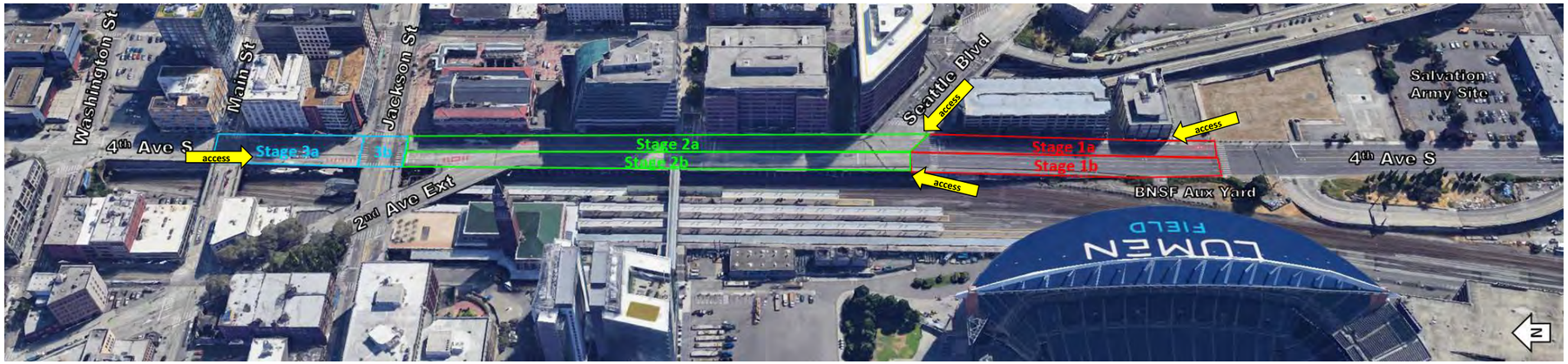


GraphicSchedule.com

WSBLE 4th Shallow - Option 1W

Conceptual schedules for brainstorming purposes only

DRAFT rev 3
JRW 18-Aug-23



	2030				2031				2032				2033				2034				2035				2036				2037				2038				2039				2040				2041				2042			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	**BASELINE ASSUMPTION (durations from Nov 2022 conceptual schedule)**																																														
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32									Stage 3a - Replace 4th Ave Viaduct - North of Jackson to Main - Full Width (duration equal to Stage 2b - conservative)																																											
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CONSTRAINTS
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- 2nd Ave Extension and Jackson cannot be closed at the same time
- Maintain one access to Union Station Garage (may require a temporary structure when traffic is on west side)

BASELINE RISKS
- Need to add time for demo of counterfort wall at Seattle Blvd
- Stages 2b & 3 could take longer than shown due to BNSF restrictions on work adjacent to tracks
- Highly dependent on MOT phasing. Very little opportunity to re-seqence if delays are encountered.

OPTION 1 RISKS
- Stage 2b could take longer than shown due to BNSF restrictions on work adjacent to tracks
- Demolition of west side of viaduct first may be more challenging due to structural configuration.

OPTION 1W BENEFITS
- Shortens 4th Ave traffic impacts by about 4 years (3.5 years vs 7.5 years)
- Shortens project duration by about 2.5 years.

GraphicSchedule.com

OPTION 2

Close 4th Ave. South and reconstruct viaduct in one stage

Overview: This option would close 4th Ave. South to traffic between Main St. and the I-90 off-ramp and close South Jackson St. at 4th Ave. South and reconstruct the 4th Ave. viaduct in one stage. This option was developed to establish the fastest possible schedule to reconstruct the 4th Ave. viaduct structure if 4th Ave. South could hypothetically be closed to traffic for an extended period.

Staging Concept:

The construction activities and durations are assumed as follows:

- Shut Down all of 4th Ave. South – Set up detours and temporary accesses.
  - Assume a 6-month duration.
- Demolish all the existing 4th Ave. viaduct and the South Jackson St. Bridge. at 4th Ave.
  - Assume a 6-month duration.
- Start slurry wall operations at South Jackson St. working out with four rigs at peak (two average).
  - Sheet piling on the west side.
  - 7.5 feet/rig/day?
  - 2500 feet per side.
  - Assume a 12-month duration.
- Install new combined overflow sewer (COS)
  - 2,500 feet long.
  - Assume a 3-month duration.
- Pull sheet pile if desired.
  - Assume a 1-month duration.
- Construct pier walls and caps (1500 feet each side).
  - Two headings on each wall.
  - Assume a 7-month duration.
- Place precast box girder (150,000 SF deck area).
  - 4 feet deep 4 feet wide boxes.
  - Assume a 6-month duration.
- Place South Jackson St. Bridge and Main St. Bridge.
  - Assume a 3-month duration for each structure.
- Construct 4th Ave. retaining walls south of Seattle Blvd. (750 linear feet)

OPTION 2

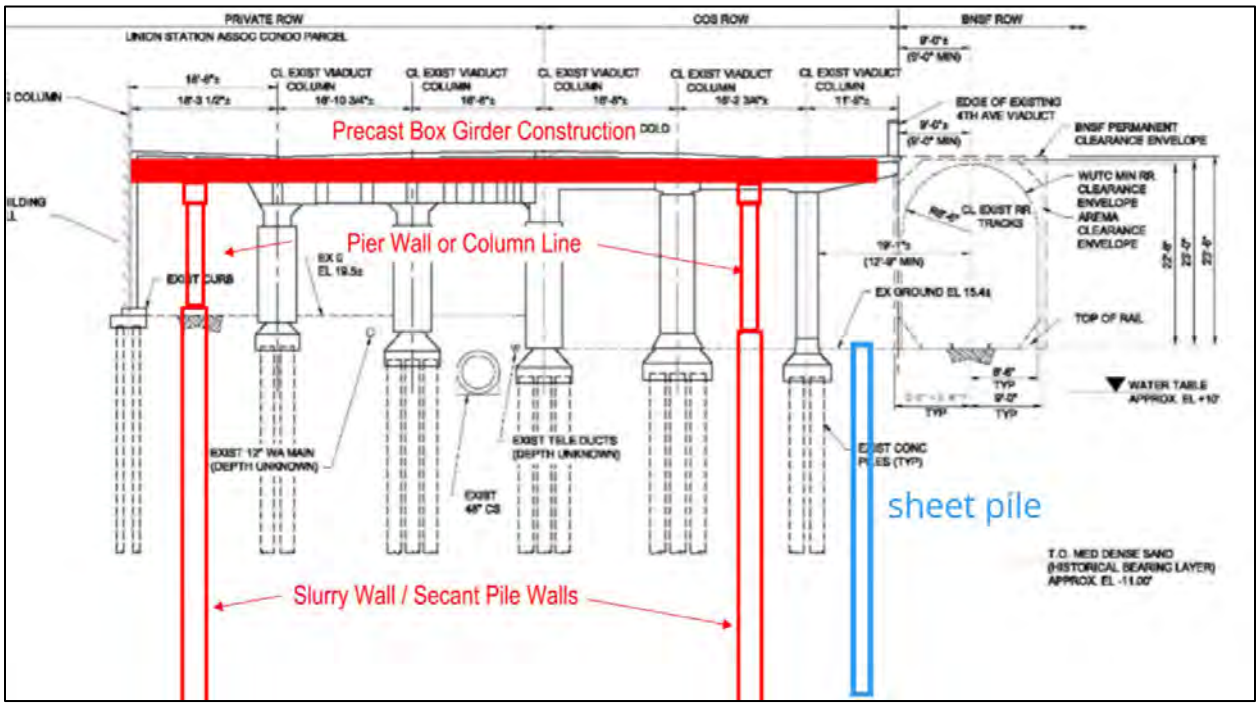
Close 4th Ave. South and reconstruct viaduct in one stage

- Assume mechanically stabilized earth (MSE) walls would be used.
- Assume a 3-month duration.

o Finish roadway and sidewalk surfaces.

- Assume a 3-month duration.

Project Concept Image



Typical section assumed for reconstruction of the 4th Ave. viaduct

Traffic Detours & Closures:

Traffic effects to the surrounding area would be extreme. This concept assumes the following traffic detours for a 4th Ave. South full closure (I-90 to S. Jackson):

- North Bound (NB) 4th Ave. to intercept traffic as far south as First Ave. South Bridge over Duwamish at State Route 509 (SR-509).
  - Detour route to downtown via State Route 99 (SR-99) to Alaskan Way and 1st Ave.
  - Full closure of 4th at Interstate 90, detour via Edgar Martinez Way to 1st Ave.
- South Bound (SB) 2nd Ave. extension detour at 2nd/Washington to S. King St. to 1st Ave./Alaskan Way.
  - Remove parking; potential one-way on 2nd Ave. S., Washington to King.

- S. King St. to 1st Ave. and Alaskan Way/SR-99.

- It should be noted that the closure exhibit originally identified a 4-year total closure of 4th Ave. between S. Jackson St. and Main St. The workshop team shows 2 years; however, it is noted that this is likely optimistic, and the closure could extend between 2-4 years to account for additional construction activities likely needed to complete the project in this area.
- There would be periodic lane closures along 4th Ave. for both the baseline and option concepts to support the completion of the 4th Shallow CID Station and access features activities that are not captured in the schedule. These would be comparable for both options.

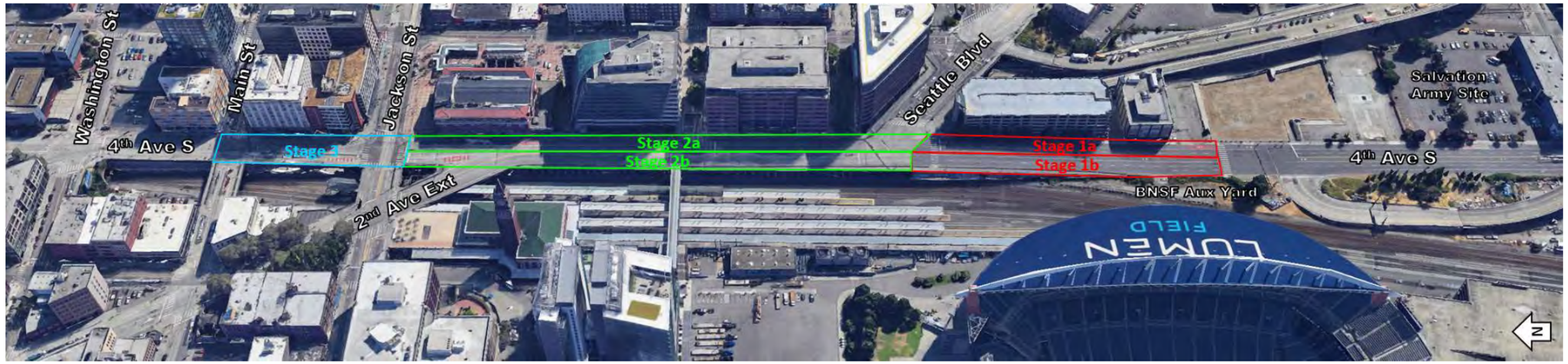
Schedule Benefits:

- Reduces traffic effects on 4th Ave. by about 4.5 to 5.5 years (2.5–3 years vs. 7.5 years).
- Reduces project duration by about 3.5 years.
- This option also reduces risks related to schedule delays, because there is more room to work and less sequential phasing.
- This options also provides a much safer work environment.

WSBLE 4th Shallow - Option 2

Conceptual schedules for brainstorming purposes only

DRAFT
JRW 17-Aug-23



	2030				2031				2032				2033				2034				2035				2036				2037				2038				2039				2040				2041				2042			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	**BASELINE ASSUMPTION (durations from Nov 2022 conceptual schedule)**																																														
2					**Reduce 4th Ave to 2 Lanes South of Jackson (1 lane each direction)**																																				**Full Closure of Stadium Station**									
3					Access Staging & Slurry Walls - Salvation Army Site																				**Full Closure of 4th Ave - Jackson to Main**																		**Link System Shutdown**					
4					Demo Counterfort Wall at Seattle Blvd (not included)																																												
5					**Shift 4th Ave Traffic to West Side**																																												
6					Stage 1a - Cut & Cover 4th Ave - I-90 to Seattle Blvd - East Side																																												
7									**Shift 4th Ave Traffic to East Side**																																										
8									Stage 1b - Cut & Cover 4th Ave - I-90 to Seattle Blvd - West Side																																											
9													**Shift 4th Ave Traffic to West Side**																																									
10													Stage 2a - Replace 4th Ave Viaduct - Seattle Blvd to Jackson - East Side																																									
11																	**Shift 4th Ave Traffic to East Side**																																			
12																	Stage 2b - Replace 4th Ave Viaduct - Seattle Blvd to Jackson - West Side																																			
13																									**Shift 4th Ave Traffic to West Side / Open 2nd Ave Extension / Close Jackson**																													
14																													Stage 3 - Replace 4th Ave Viaduct - Jackson to Main - Full Width																							
15																																	Stage 4 - Construct 4th Shallow CID Station - Under New Viaduct																
16																																												Systems (not included)				
17																																												Reconstruct Stadium Station in Busway				
18																																													Cutover @ Stadium			
19	**OPTION 2 - FULL CLOSURE OF 4TH AVE**																																														
20					**Full Closure of 4th Ave from Jackson to I-90 Ramps**																																												
21					**Close 4th Ave**																																												
22					Establish Access																																												
23						Demo Existing 4th Ave Viaduct + Jackson Viaduct																																												
24							Construct Slurry Walls from Washington to South Cut & Cover (2,500' ea side, start at Jackson, 1-2 rigs ea side)																																												
25									Construct 4th Ave Retaining Walls South of Seattle Blvd (assume MSE)																																											
26										Construct Pier Walls + Caps (1,500' ea side, start at Jackson, 2 headings ea side)																																											
27											Place Precast Box Girders - New 4th Ave Viaduct (1500 sq ft deck area)																																										
28												Finish Roadway + Sidewalk Surfaces - New 4th Ave Viaduct																																									
29													**Open 4th Ave**																																								
30														Move 48" Pressure Sewer & Other Utilities																																								
31														Place Jackson St Crossing																																								
32															**Open Jackson**																																						
33															Place Main St Crossing																																							
34																Construct 4th Shallow CID Station - Under New Viaduct																																							
35																																													Systems (not included)				
36																																													Reconstruct Stadium Station in Busway				
37																																														Cutover @ Stadium			
38																																																

BASELINE RISKS
- Need to add time for demo of counterfort wall at Seattle Blvd
- Stages 2b & 3 could take longer than shown due to BNSF restrictions on work adjacent to tracks
- Highly dependent on MOT phasing. Very little opportunity to re-seqence if delays are encountered.

OPTION 2 RISKS
- Carmegeddon
- Durations are conceptual - need to be validated by design and estimating

OPTION 2 BENEFITS
- Shortens 4th Ave traffic impacts by about 4.5 years (3 years vs 7.5 years)
- Shortens project duration by about 3.5 years.

GraphicSchedule.com

OPTION 3

Construct a pipe box tunnel under the 4th Avenue viaduct

Overview: This option seeks to minimize surface disruptions to 4th Ave. South by constructing a pipe box tunnel beneath the existing 4th Ave. viaduct structure. This concept would install a series of interlocking steel pipes in a rectangular configuration using micro-tunneling techniques between excavated pits and shafts. The interior of the pipe boxes is then mined out, braced with temporary supports, and then finished with a concrete lining to create the transit tunnel. Access shafts would be installed to accommodate vertical circulation and ventilation.

Constraints:

- Tangent track (minimum curves to be accommodated for within the pipe box).
- Constant gradient between shafts.
- Maintaining DEIS configuration, alignment, and terms of reference (TOR) to the extent possible.
- Elevation for the top of pipe box to avoid the underside of piles to the extent possible; Micro-tunnel boring machine (TBM) to account for potential clash with timber/concrete piles.
- Permanent columns within the pipe box to align with existing viaduct piles.
- As-built location of demolition pile details.
- Futureproof pipe box permanent structure to account for potential viaduct replacement.
- Ground water table (GWT) to be maintained during all construction activities.

Geotechnical Considerations:

- Elevation for the top of pipe box aims to be within the post glacial and/or glacial deposits.
    - When the pipes or tunnel fall with in fill, plan for deep soil mixing (DSM) or alternative ground improvement.
- Boulders are unlikely in the post glacial but are highly likely in glacial deposits.
    - Boulders are likely in these units, although less likely in the fill and post glacial soils than in the glacial soils. Likely to be concentration of boulders in post glacial soils in contact with glacial soils.
- Micro TBM to account for potential encounter with boulders.
- GWT 5-15 ft below ground surface.

OPTION 3

Construct a pipe box tunnel under the 4th Avenue viaduct

Potential Effects and Mitigations:

Main elements include BNSF track and tunnel, 4th Ave. viaduct, and adjacent buildings (assumed to be on [timber] piles):

- Use industry practices for settlement analysis and vibrations from construction and operation (attenuating sleepers or floating track slab minimizes operational vibration).
- Aim to avoid direct clash with piles (as much as possible); pipe connections designed to be relatively watertight.
    - When local micro tunnel projects have encountered timber piles (100 years old), the cutters create 3 ft to 6 ft long by 1-inch thick by 4 ft to 6 ft wide wood strips that intertwine and clog cutterhead. It will likely require several interventions.
- Low effect for pipe box; effects from shafts same from DEIS.
- DSM or similar ground improvement where post glacial and/or glacial deposits provide insufficient cover.
- InSar, or similar satellite settlement, to review to understand history settlement trends as part of the design.

Constructability Considerations:

- Micro-tunnels and HDD pipes can and have drilled significantly longer distances than those required for the station and running tunnel.
- Verify the limits of pipe box drilling length (influences shaft locations).
- "Intervention" halfway with DSM or Jet Grout Block with SEM minimum in-between the ends of the two directions or introduction of a shaft midway to retrieve Micro TBM (if necessary).
- Possible staging of open cut (U-wall section to C&C tunnel) vs. need for full access (assumed).
- Shaft construction walls assumed to be secant pile wall per BNSF interface (to review use of slurry wall in accordance with other VE studies).
- Shaft construction/MOT/viaduct replacement is per the current DEIS concept.
- In-tunnel ground water control (dewatering).
- Temporary steel frames to align with existing viaduct piles.
- Potential grouting of tongue-and-groove to better seal the clutch against water seepage.
- Assume 3 days per pipe per 100 m length (325 ft).
- Full cross section excavation rate assumed at 0.5 ft/day (0.15 m/day).
- Permanent works per industry standard production rates.

OPTION 3

Construct a pipe box tunnel under the 4th Avenue viaduct

- See staging diagrams for additional details.
- Refer to the attached memo prepared by Gall Zelder in response to the Sound Transit Project Team's questions for this method.

Construction Staging and Duration Assumptions:

Stage 1 – Relocate 48-inch pressure sewer and other utilities.

Stage 2 – Construct TBM retrieval pit at Main St.

- Assume a 10-month duration.
- Staged construction with two-lane restriction on 4th Ave.
- Establish offline access/ramp down into pit from Main St.
- Install temporary deck/re-open 4th Ave. full width.

Stage 3 – Construct south jacking pit and east track box under 4th Ave. (south of Seattle Blvd. – concurrent with Stage 2).

- Assume a 2-year duration.

Stage 3a

1. Establish staging area in BNSF Auxiliary yard and SA yard.
2. Shift traffic to the east side of 4th Ave.
3. Install slurry wall/secant pile on west side to centerline of 4th.
4. Install temp sheet pile support of excavation (SOE) for south side of jacking pit on west side of 4th.
5. Install temp sheet pile SOE for center between east and west track boxes south of jacking pit.
6. Install temporary deck over western portion of future jacking pit.

Stage 3b

1. Shift traffic to west side of 4th Ave.
2. Install permanent east SOE and remaining section of permanent west SOE and ½ of jacking pit sheet pile south wall on east side of 4th.
3. Install temporary deck over eastern track box south of the jacking pit.
4. Use temporary deck over eastern track box for access to jacking pit from SA site for excavation and shoring the full width/depth of pit from east side.
5. Set up boring equipment and start pipe drilling operations.

OPTION 3

Construct a pipe box tunnel under the 4th Avenue viaduct

Stage 3c: During Pipe Drilling and Station Excavation

1. Excavate/construct/backfill east track box and a portion of west track box under a temporary decking on the east side of 4th Ave. – access from SA site.
2. Upon completion of the east track box, support of pipe drilling operations through the east track box is provided on the SA site at the 4th Ave. ROW within the permanent SOE via crane hoisting operations.
3. Remove temporary deck on east side, complete backfill and install temporary pavement, and install temporary deck over the east side of jacking pit box.
4. Open all lanes on 4th to traffic.

Stage 4 – Construct station access shaft south of Jackson below viaduct (concurrent with Stage 2).

- Assume a 20-month duration.

Stage 5 – Construct secondary vent/egress shaft at Weller below viaduct (concurrent with Stage 2).

- Assume a 1-year duration.

Stage 6 – Construct pipe box tunnels (pipe drilling, excavation and support, and final lining).

a) From TBM retrieval pit to station access shaft (after Stage 2).
b) From south jacking pit to secondary egress shaft (after Stage 3).
c) From station access shaft to secondary egress shaft (after Stage 4).

Stage 7 – Construct south portal track boxes in Salvation Army Site (after Stage 3) and west portal box in 4th Ave. after station excavation.

Stage 7a – During pipe drilling and station excavation.

1. Support for the pipe drilling and station excavation is provided on the SA site at the 4th Ave. ROW within the permanent SOE via crane hoisting operations.
2. The single combined east and west track box structure excavation, construction, and backfill continues on the SA site during the pipe drilling and station excavation.

Stage 7b: After completion of station excavation and concrete operations.

1. Shift traffic to east side of 4th.
2. Excavate/construct/backfill to surface the west track box and construct/backfill the remaining portion of the east track box within the jacking pit. Concurrently construct and backfill the remaining portion of the east track box on the SA site that was used to support drilling and station excavation operations.

3. Construct permanent retaining wall on the west.
4. Remove temporary decking, finish backfilling, and install temporary pavement.
5. Open all lanes to traffic on 4th Ave.

Stage 8 – Construct shaft final lining.

a) At station access shaft (after Stage 6c).

b) At secondary egress shaft (after Stage 6c).

Stage 9 – Construct permanent lids/street restoration in 4th Ave.

a) Stagged construction with two-lane restriction on 4th Ave.

b) At TBM retrieval pit.

c) At south jacking pit.

CIVIL SUBSTANTIAL COMPLETION/HANDOVER TO STATION/TRACK/SYSTEMS CONTRACTS

Notes:

- *The workshop team developed two possible staging concepts to address the construction of the jacking pit on 4th Ave. South. These are included in the attached exhibits.*
- *One activity of 8 months duration on the schedule for the "Street Restoration, 4th Ave staged" to account for demolition, shaft construction, and deck reconstruction.*
- *Vertical circulation is shown on page 41. Both stairs and escalator are provided at the ends of the platforms. An elevator is provided in the middle of the platform.*
- *Ventilation can either be brought directly up to the surface from both ends of the station through 2 shafts which would house the ventilation fans.*
- *The geologic profile shown is based on what was available at the time of the Schedule Analysis study. It is noted that the geologic profiles for 4th and 5th Aves are likely different, however, for the purposes of conveying the pipe box concept, it was discussed amongst the SA team and it was concluded that the profile shown is representative for this project area where the alignments at plan are only one avenue apart.*
- *Further to the above, the pipe box concept is proposed such that it would be installed below the tips of the existing viaduct piles (see figures on page 68 to 72). Backgrounds shown of the existing viaduct piles are based on information made available to the Schedule Analysis team during the study. It is understood based on construction records that the piles were originally driven into competent soil (e.g. Recent Gravel Deposits / Cohesionless Sand and Gravel) below the liquefiable soils. If the proposed concept were to be reviewed in more detail, the tunnel vertical alignment versus the geologic profile would be the initial task for the engineering team to review. The alignment would be selected such that competent soil cover above the pipe box would be maintained, however, with the variability of the ground, it may not be possible to have competent soil*

cover above the entire pipe box alignment. In these select locations, pre-excavation ground treatment (e.g. jet grouting) can be performed to ensure the permanent structure is not within the liquifiable soils. An engineered solution can be provided and therefore, a variability of the geologic profile is not considered a fatal flaw for the proposed concept.

- *The constraints shown are just to highlight the aspects of the proposed concept to be reviewed in more detail should the proposed concept move to an engineering review level. Each of the constraints can be studied and an engineering solution can be determined. These constraints are not considered fatal flaws for the proposed concept.*
- *Even with these constraints, the Schedule Analysis team estimated 8 years to complete the heavy civil work for the station and running tunnel. Based on the reference schedule provided, architectural finishes and systems work would require ~2 years to complete, bring the total duration would be in the range of 10 years. This is a schedule savings of 2 years, which includes what the Schedule Analysis team thought were optimistic production rates for the demolition of the viaduct and subsequent slurry/secant pile wall construction activities.*
- *Further to the schedule savings, the pipe box concept significantly reduces the viaduct demolition and material quantities for the station. Additional schedule and material savings would be available with a reconfiguring the running tunnels to be individual pipe box tunnels. For this proposed alternative, the Schedule Analysis team opted to maintain the same concept as the DEIS, however, the individual running tunnels would further reduce impact, risk, cost, and schedule.*

Schedule Benefits:

- Approximately 8 years to complete heavy civil construction.
- Reduces extent of traffic effects on 4th Ave. South.

Traffic Detours and Closures:

- Full closure or partial closure of 4th and I-90 to Seattle Boulevard.
  - *Note: A full closure probably not needed. See the staging cartoons for south of Seattle Blvd. for alternative possibility.*
- Primary detour will be 4th via Seattle Boulevard – 6th/Airport Way – Royal Brougham (RB).
  - Consider one-way couplet conversion for detour traffic, SB via 6th, NB via Airport Way.
  - Intersection modifications at Royal Brougham/4th, RB/6th, and RB/Airport Way (see attached diagram).
  - Main St. closed at 4th.

  - Two lanes open on 4th at Main St.

- Promote Airport Way as alternate for secondary detour route from south.
- The following street closures and rough durations anticipated are listed as follows:
  - The two existing through lanes on 4th Ave. South will remain open at Main St. for the entire project to facilitate material removal during the periods of Sept. 2030 through June 2031 and Feb. 2037 through Sept. 2037.
  - Two lanes on 4th Ave. South will remain open for 2 years during the period of Sept. 2030 through Sept. 2031 at the location of the Main Station Access Shaft.
  - Two lanes on 4th Ave. South will remain open at Seattle Blvd. for 2 years during the periods of Sept. 2030 through Sept. 2032 and from May 2036 through May 2037 at the location of the south jacking pit (adjacent to Seattle Blvd.).
  - There is assumed to be a year long period of roadway restoration at the end of the excavation sites where it is assumed two lanes on 4th Ave. South will remain open.

Future Reconstruction of 4th Ave. Viaduct:

Future construction of replacement viaduct over the existing pipe box tunnel can occur in stages similarly to how it was intended in the baseline concept. The viaduct can also clear span the pipe box with two rows of supports.

The concept below would use a steel girder structure type supported on deep foundations with a splice near midspan. See the supporting sketches for details.

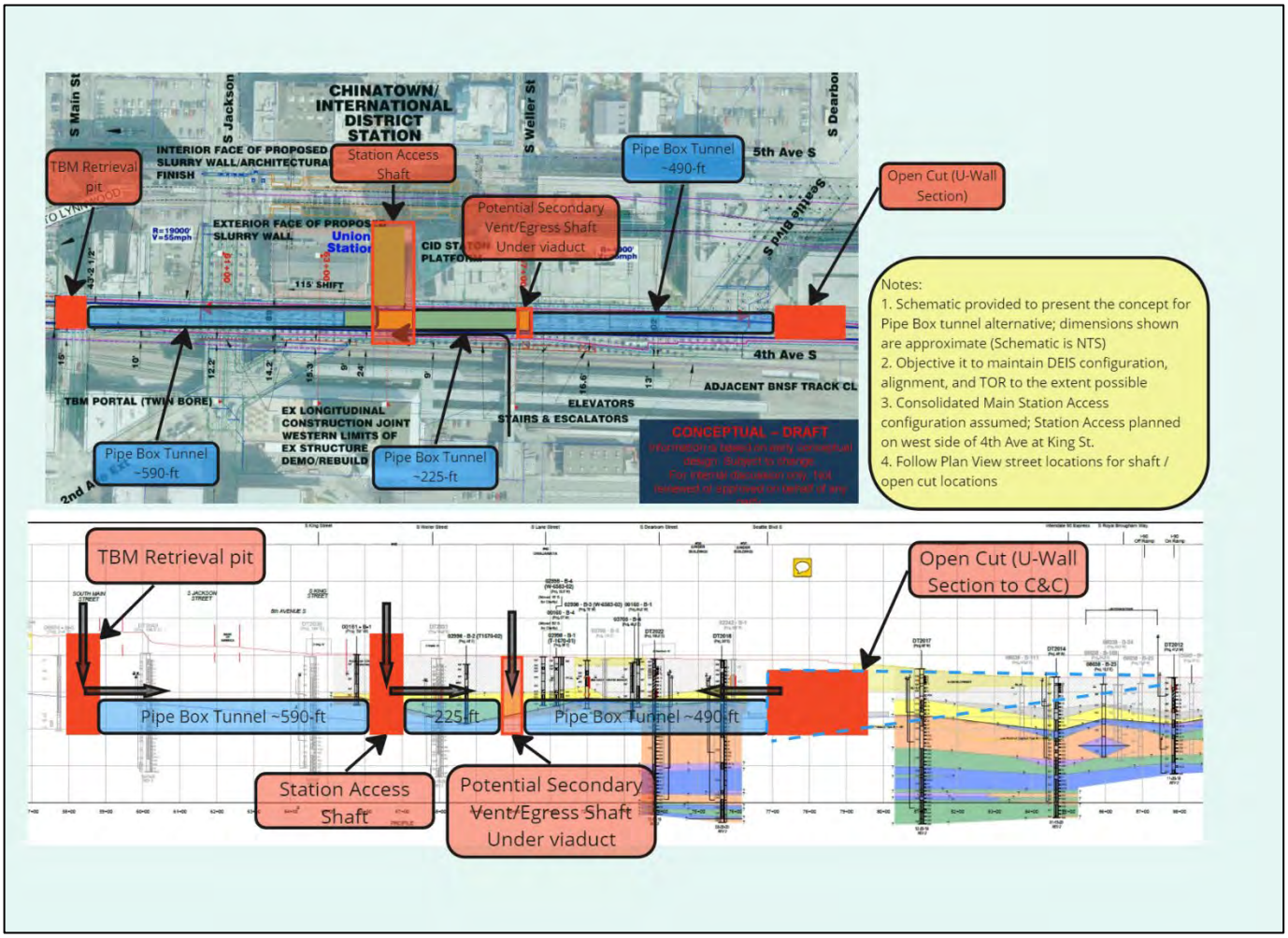
- Stage 1: Shift traffic to the west. Demolish eastern half. Construct permanent east bent and temporary falsework bent. Place eastern half of superstructure.
- Stage 2: Shift traffic to the east. Demolish western half. Construction permanent west bent. Place and splice western half of superstructure. Remove falsework bent.
- Stage 3: Shift traffic as needed to finalize roadway and sidewalks. Open to full traffic.

Multi-Column Viaduct Alternative: As an alternative that uses shorter spans across the tunnel section, like the baseline structure currently proposed, columns could be added within the pipe box section in line with the viaduct columns as shown on the subsequent page. Then drilled shafts could be placed from above to align with those columns.

OPTION 3

Construct a pipe box tunnel under the 4th Avenue viaduct

Multi-Column Viaduct Alternative Sketch

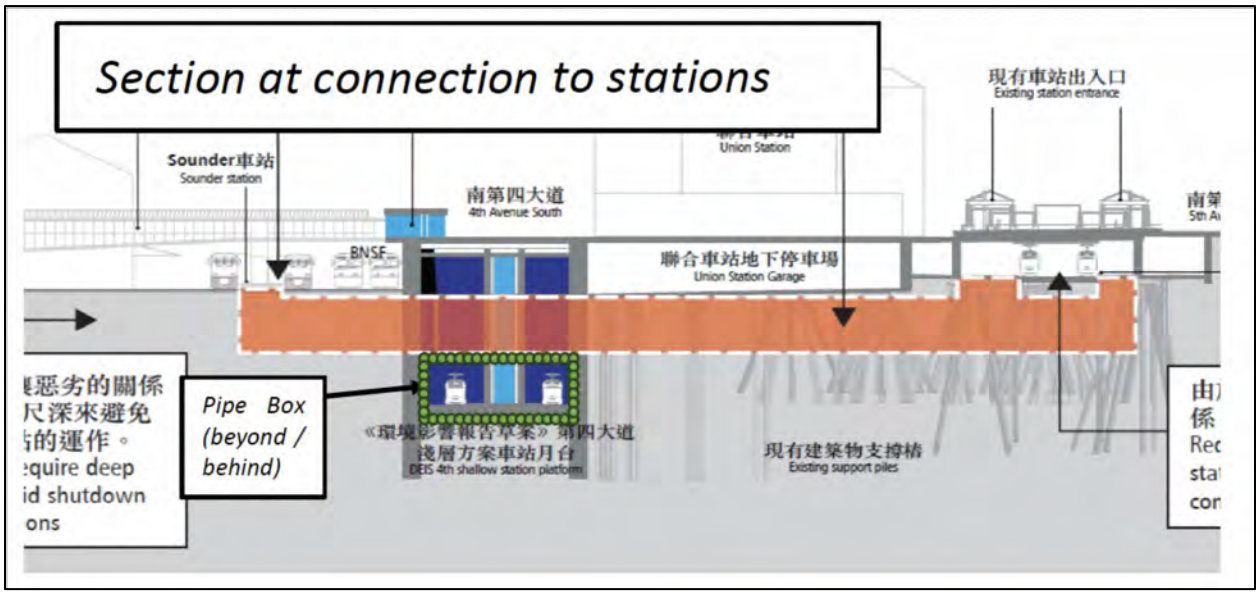


Plan and profile view of pipe box tunnel concept

OPTION 3

Construct a pipe box tunnel under the 4th Avenue viaduct

Alternative Sketches



Connection of new station to existing CID Station (similar to baseline concept)

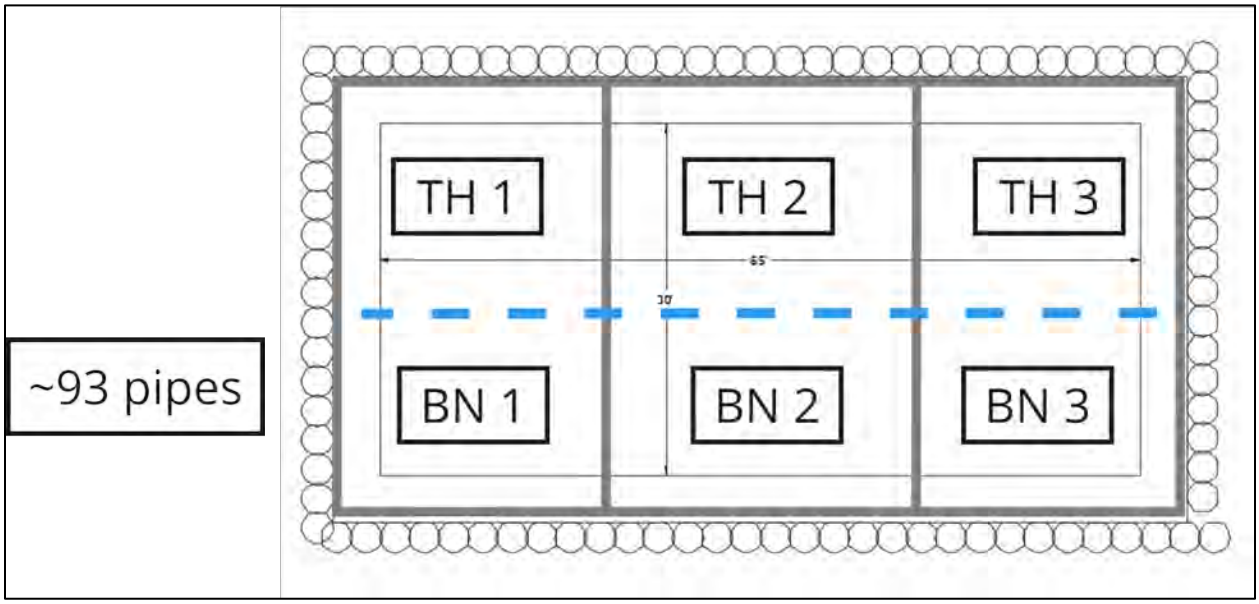


Example of micro-TBM and interlinked pipe construction

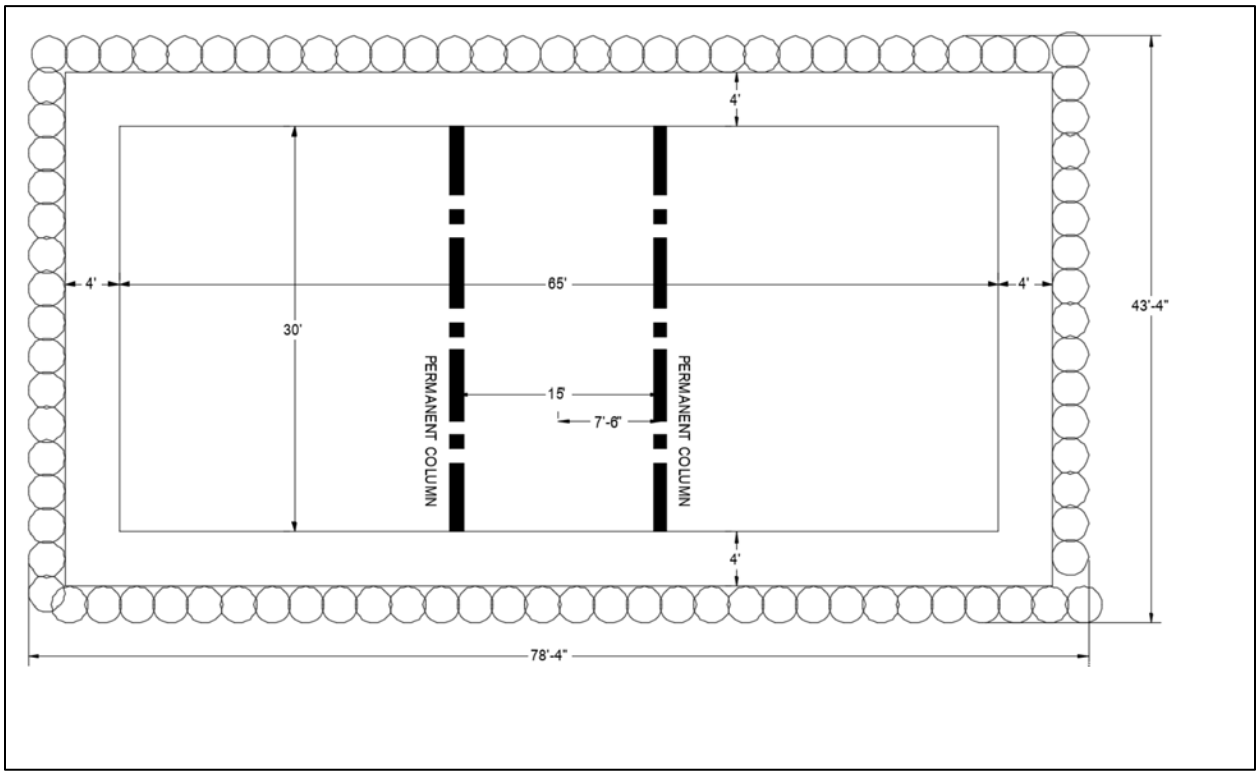
OPTION 3

Construct a pipe box tunnel under the 4th Avenue viaduct

Alternative Sketches



Conceptuel pipe arrangement

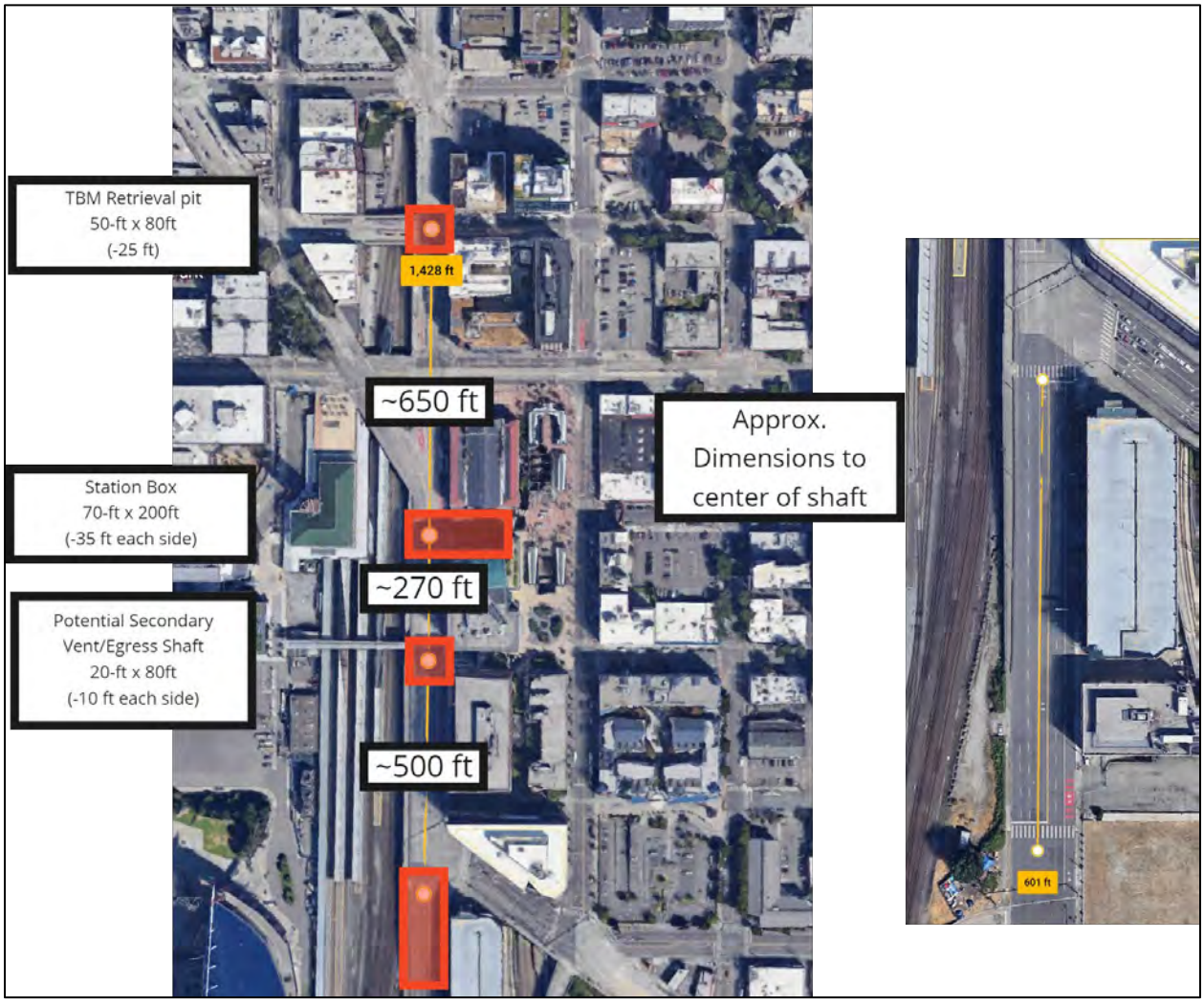


Conceptuel pipe arrangement with typical dimensions

OPTION 3

Construct a pipe box tunnel under the 4th Avenue viaduct

Alternative Sketch

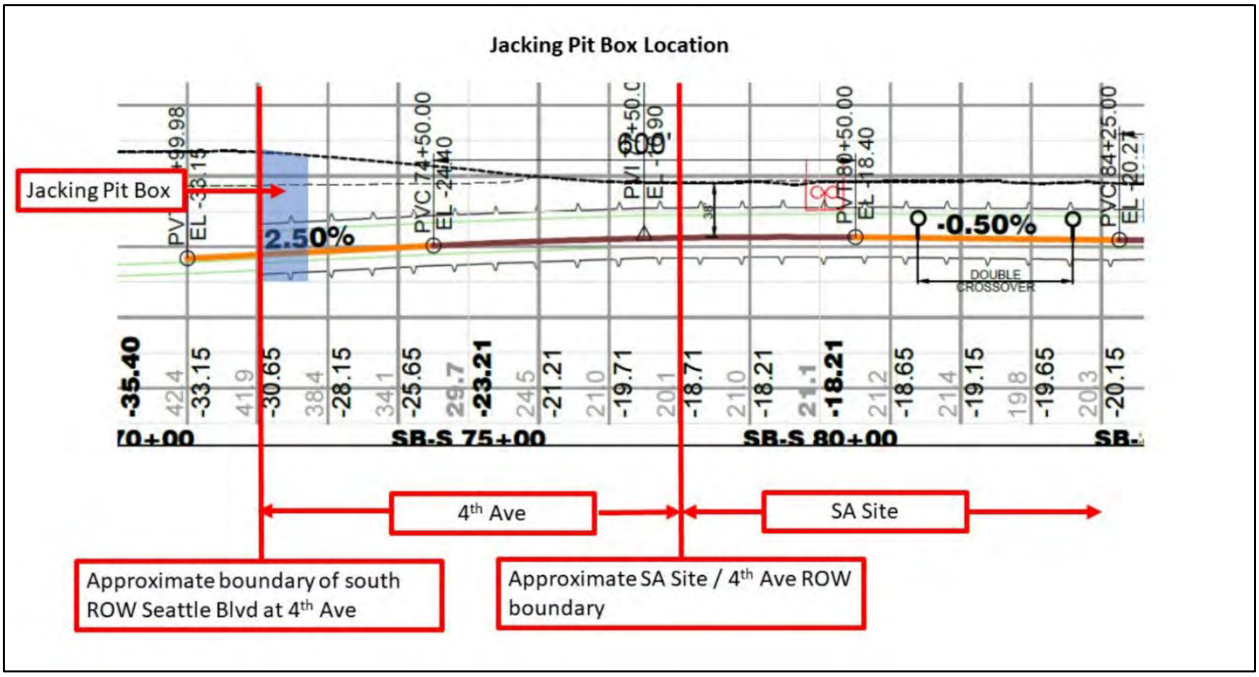


Spacing of excavations to support pipe box installation

OPTION 3

Construct a pipe box tunnel under the 4th Avenue viaduct

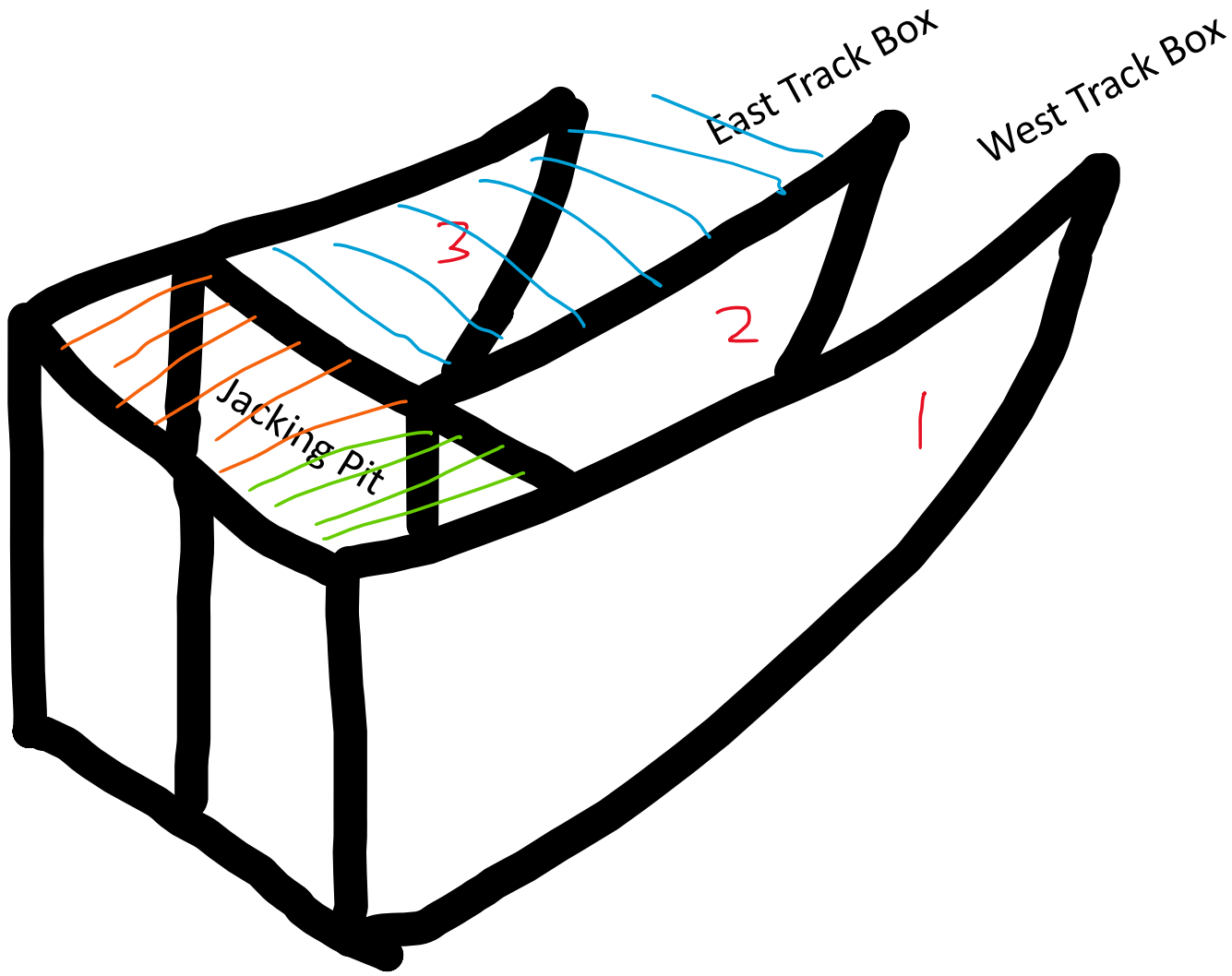
Alternative Sketch



Jacking pit box location

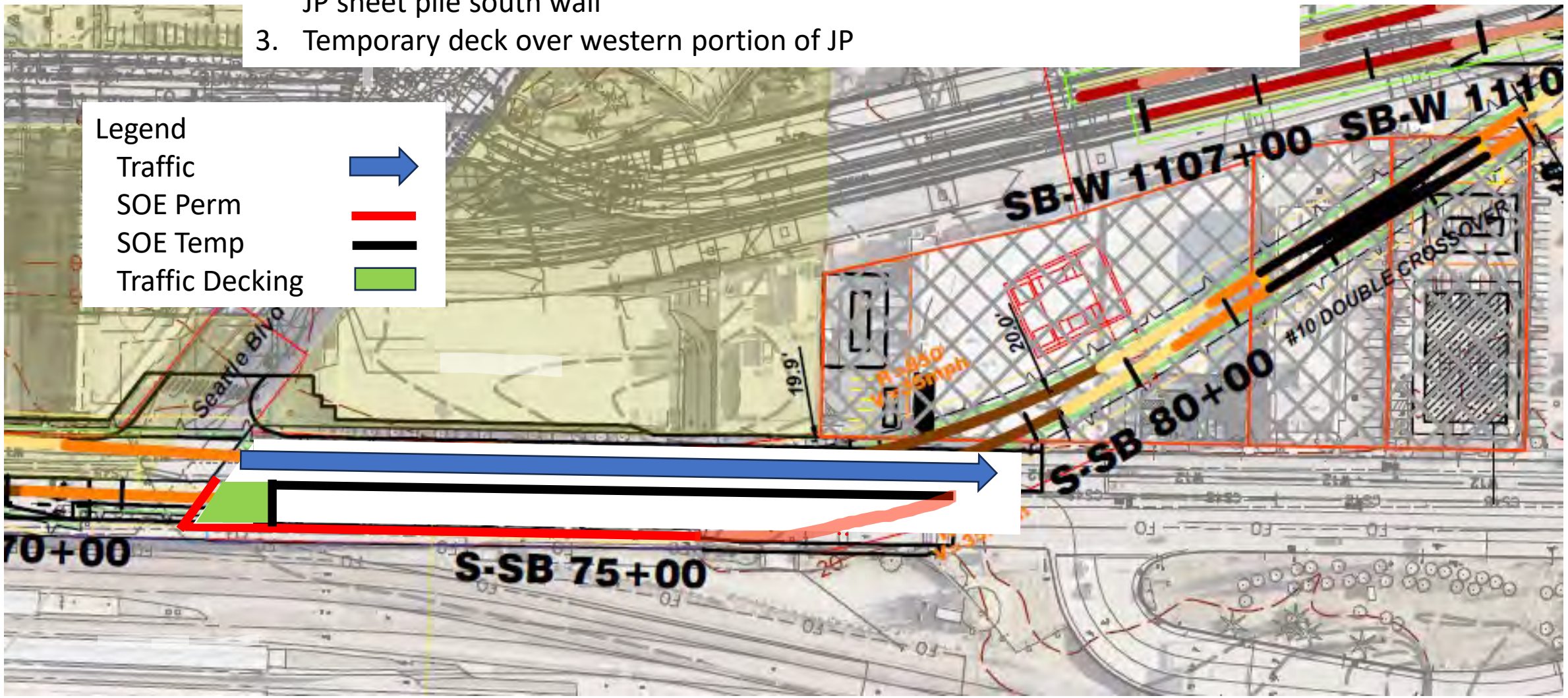
1. Shift 4th Ave traffic to East side
2. SOE 1 &2 + west half of jacking pit sheet piles
3. Temp deck over West half of Jacking pit
4. Shift 4th Ave traffic to West side
5. SOE 3 + west half of jacking pit sheet piles
6. Temp deck over East track box south of jacking pit
7. Excavate jacking pit -> start pipe drilling
8. Excavate/construct/backfill East track box from Salvation Army (plus portion of West track box under east side of 4th)
9. Temp deck over East half of Jacking pit
10. Open 4th Ave to traffic (full width)
11. Support pipe drilling activities from Salvation Army site through east track box
12. After pipe drilling activities, shift traffic to East side, then excavate/construct/backfill West track box

to Salvation Army



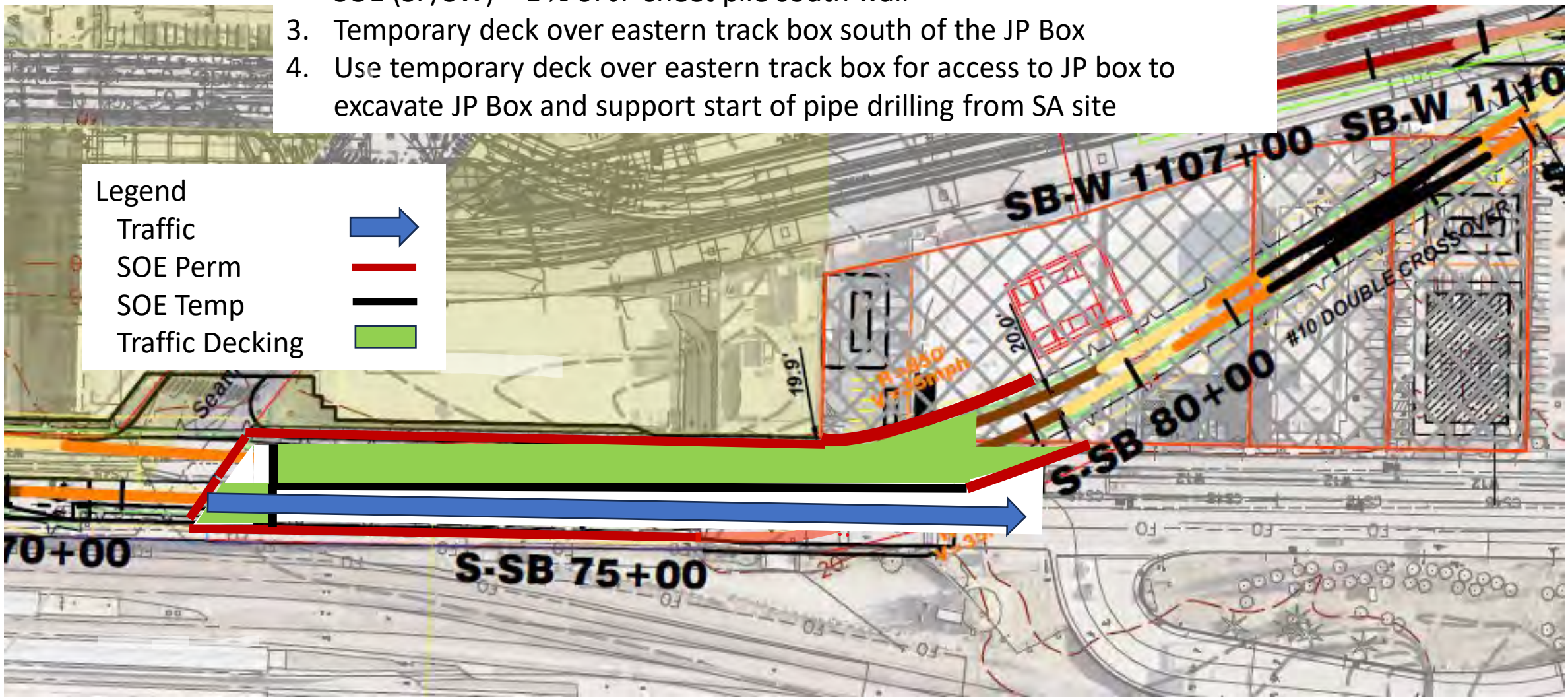
Jacking Pit Box (JP)

1. Shift Traffic to East Side of 4th
2. Install permanent SOE for West (SP/SW) and center sheet pile wall + W ½ of JP sheet pile south wall
3. Temporary deck over western portion of JP



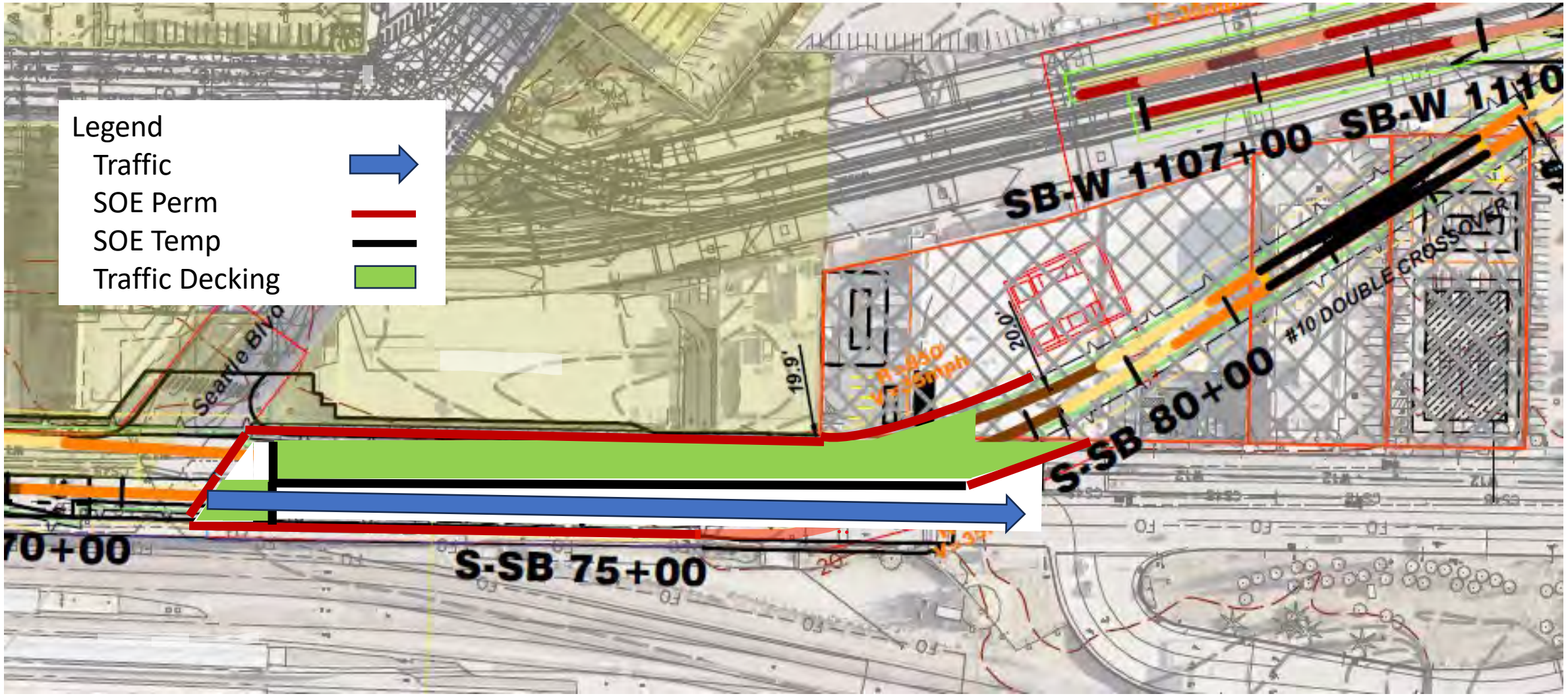
East SOE & Jacking Pit (JP)

1. Shift Traffic to West Side 4th
2. Install permanent East SOE and remaining section of permanent West SOE (SP/SW) + E ½ of JP sheet pile south wall
3. Temporary deck over eastern track box south of the JP Box
4. Use temporary deck over eastern track box for access to JP box to excavate JP Box and support start of pipe drilling from SA site



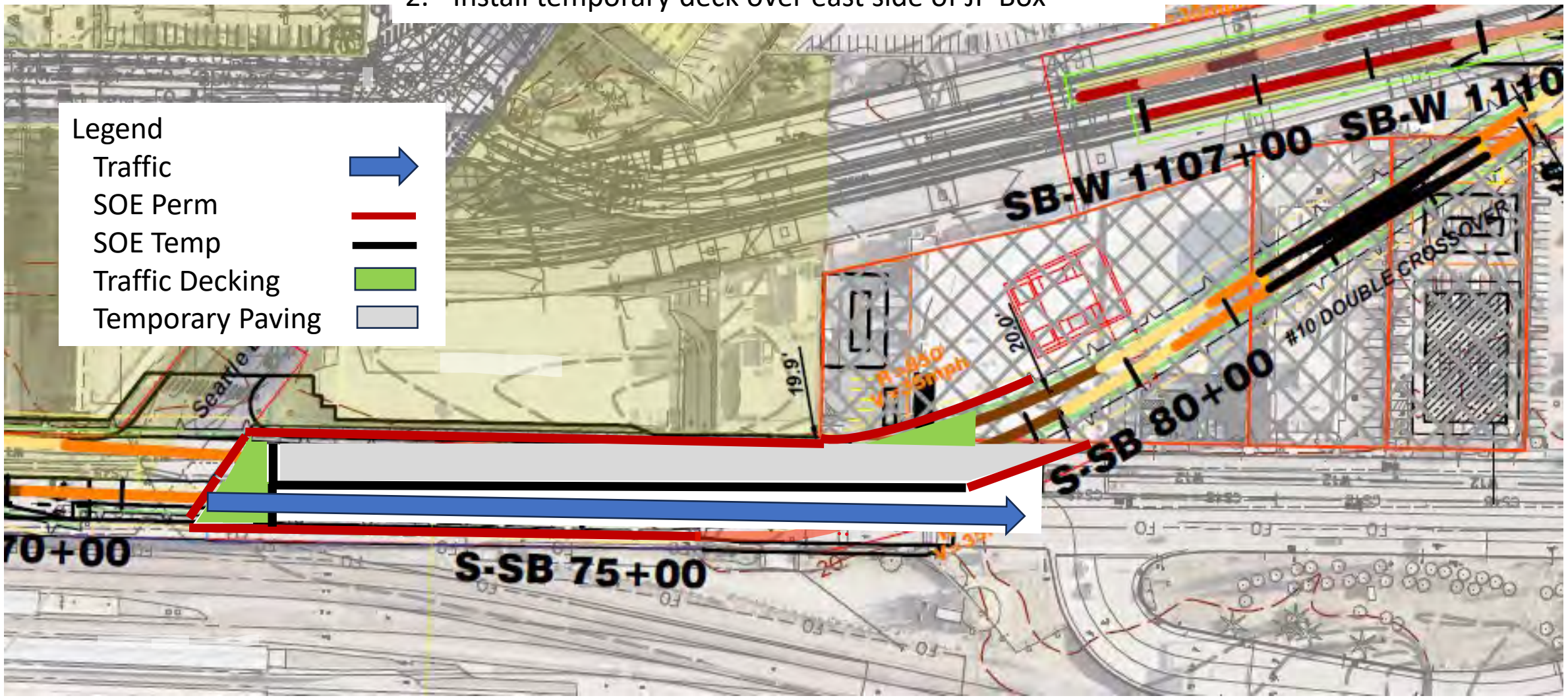
Pipe Boring Access & East Track Box Construction

1. Excavate / construct / backfill East Track Box + portion of West track box under the temporary decking on the east side of 4th Ave access from Salvation Army (SA) site

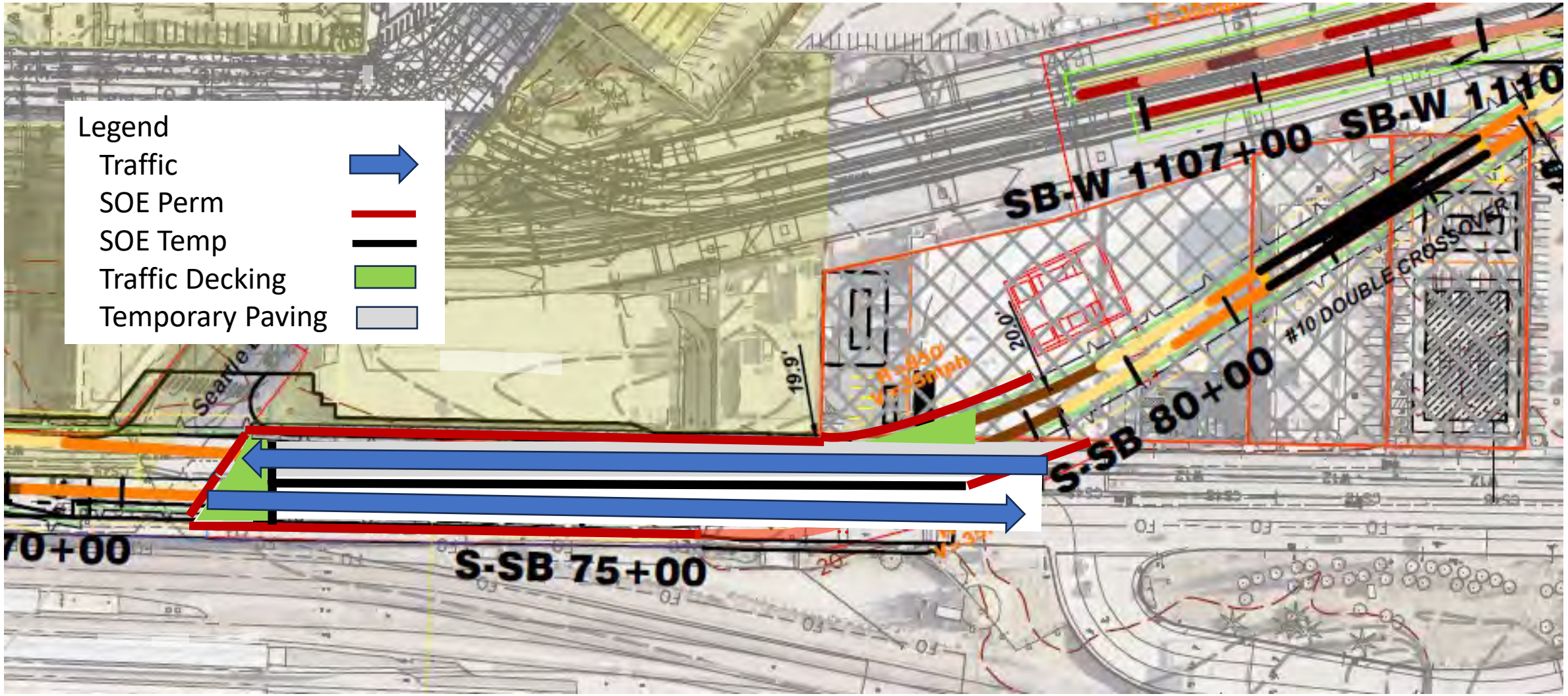


East Side Temporary Pavement

1. Remove temporary deck on East Side, complete backfill and install temporary pavement
2. Install temporary deck over east side of JP Box

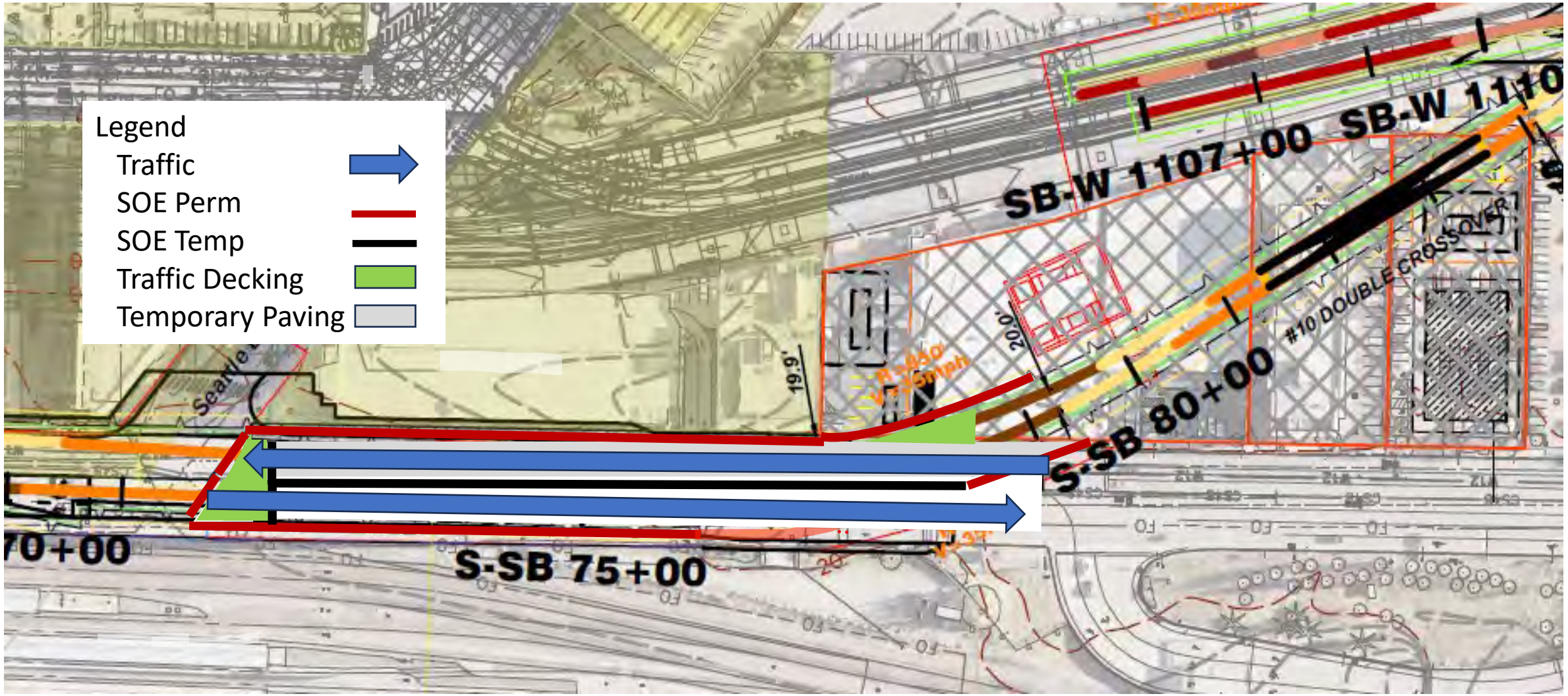


Open 4th to Traffic All Lanes



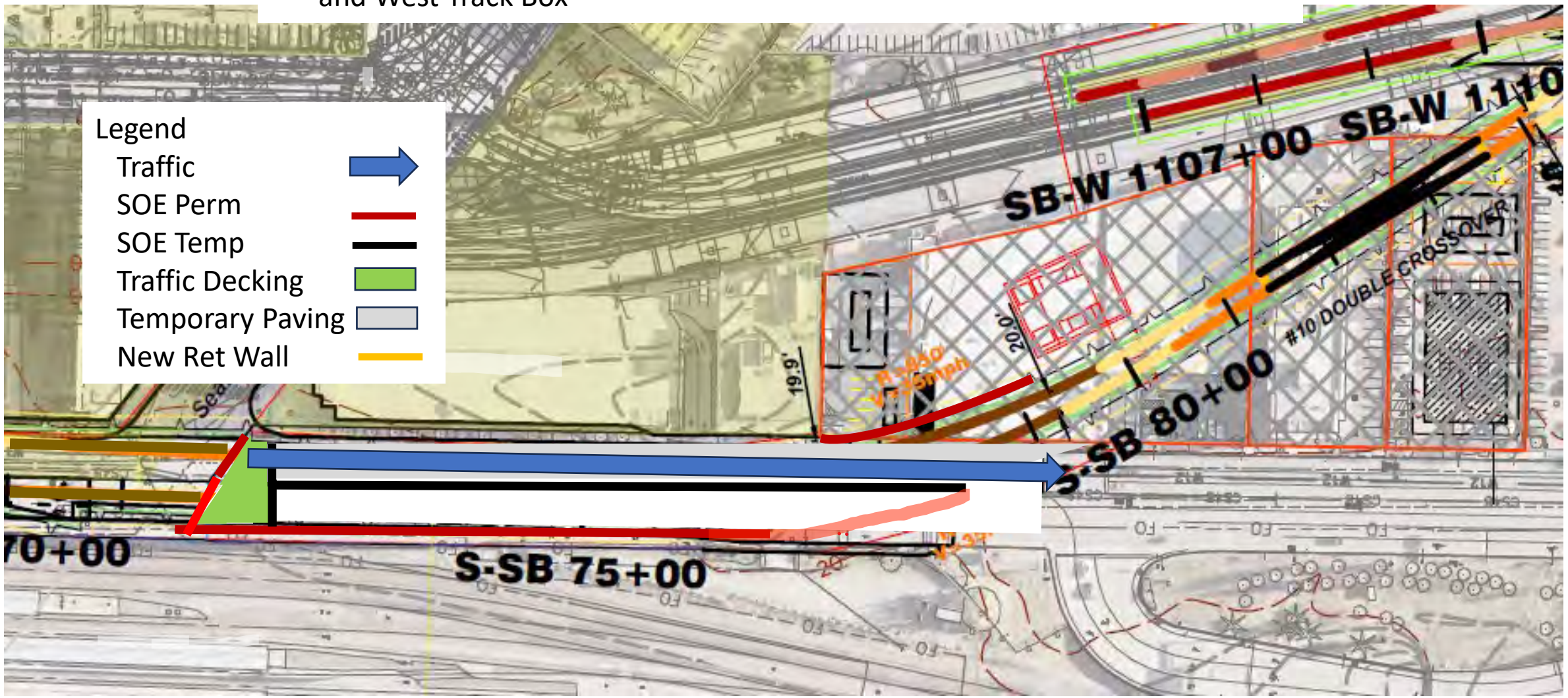
Pipe Drilling Access

1. Support Pipe Drilling operation from SA site through East track box
2. All lanes of 4th remain open to traffic



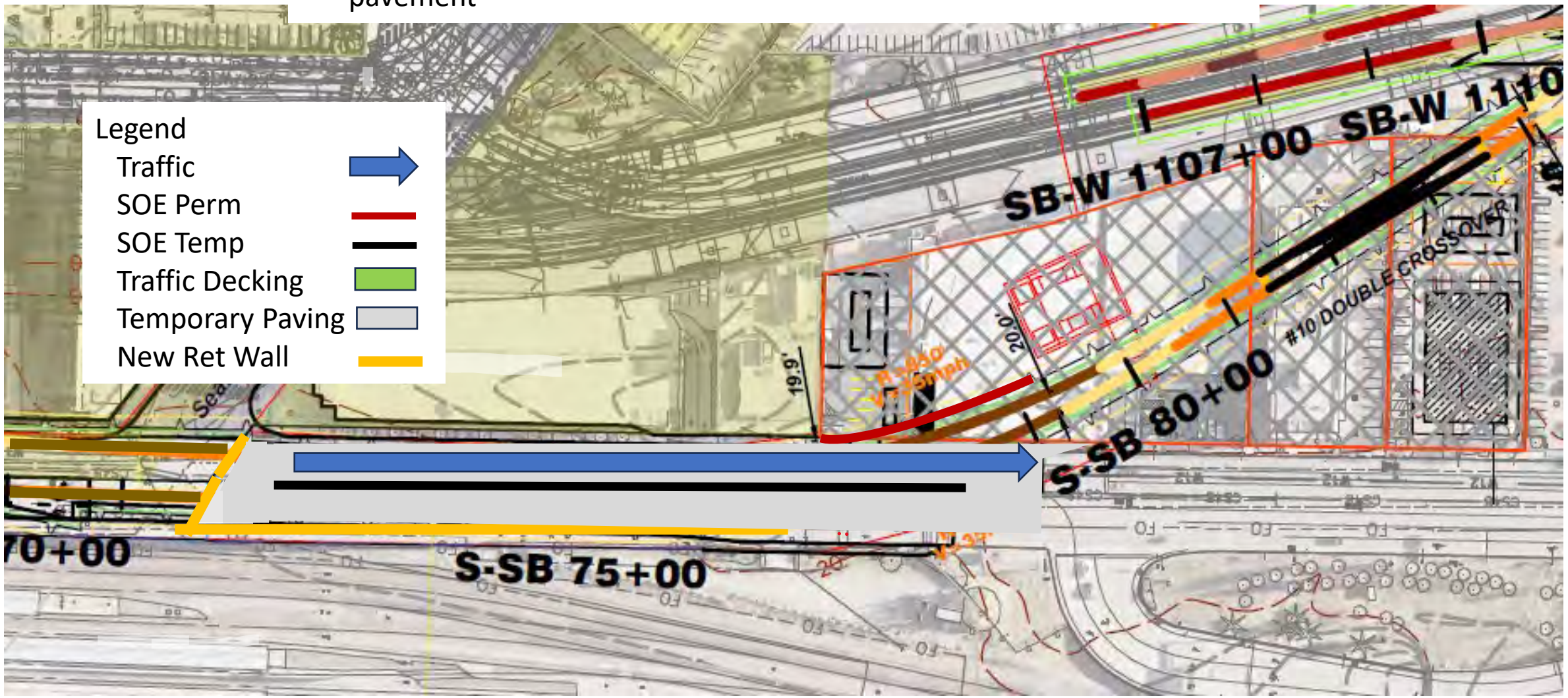
West Track Box Construction

1. Upon completion of Pipe Drilling, shift traffic to East side of 4th
2. Excavate / construct / backfill remaining portion of East Track Box in JP Box and West Track Box



West Retaining Wall Construction and Temporary Pavement

1. Construct permanent retaining wall on West
2. Remove temporary decking, finish backfilling and install temporary pavement

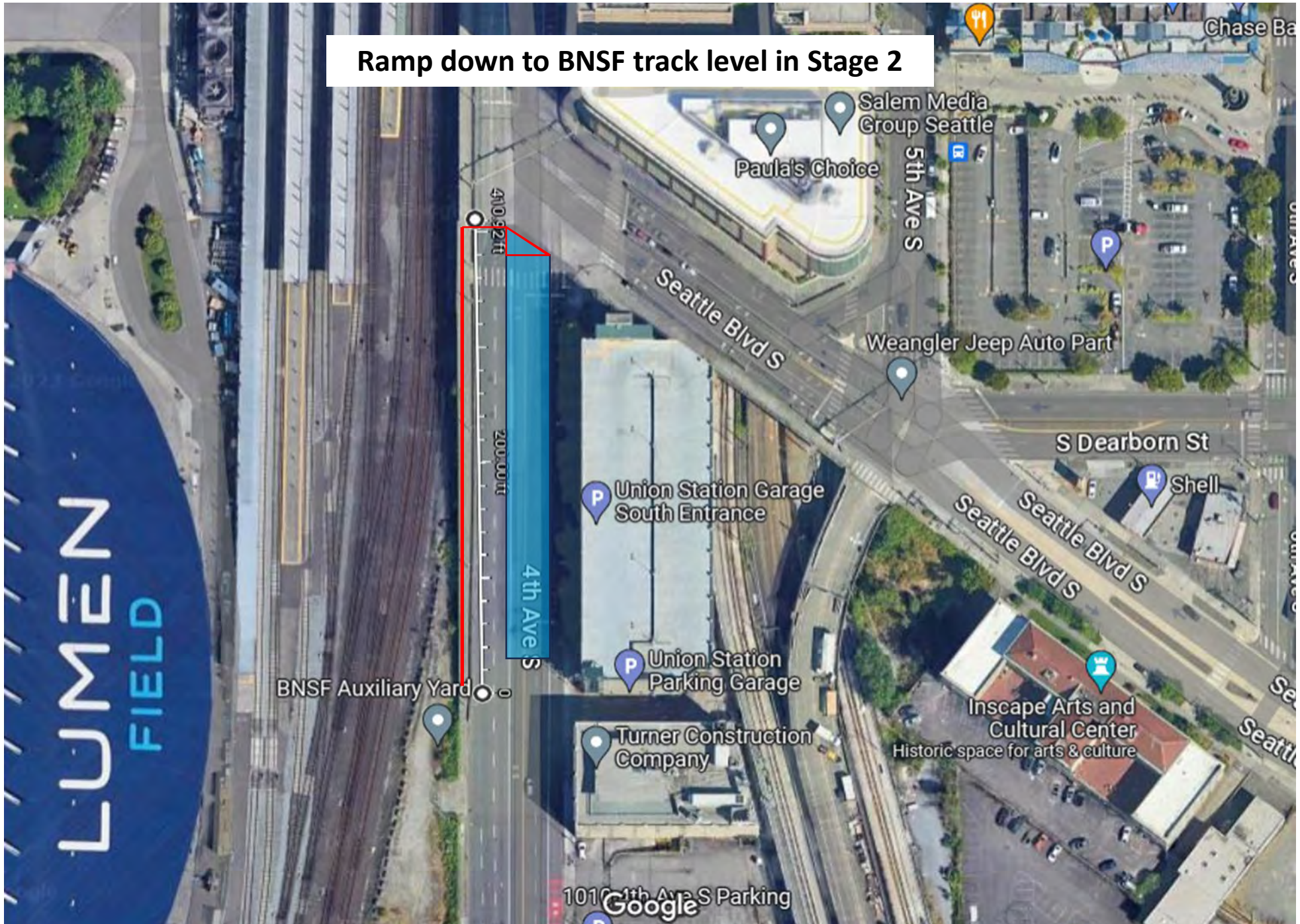


Construction of Track Boxes on SA site continues

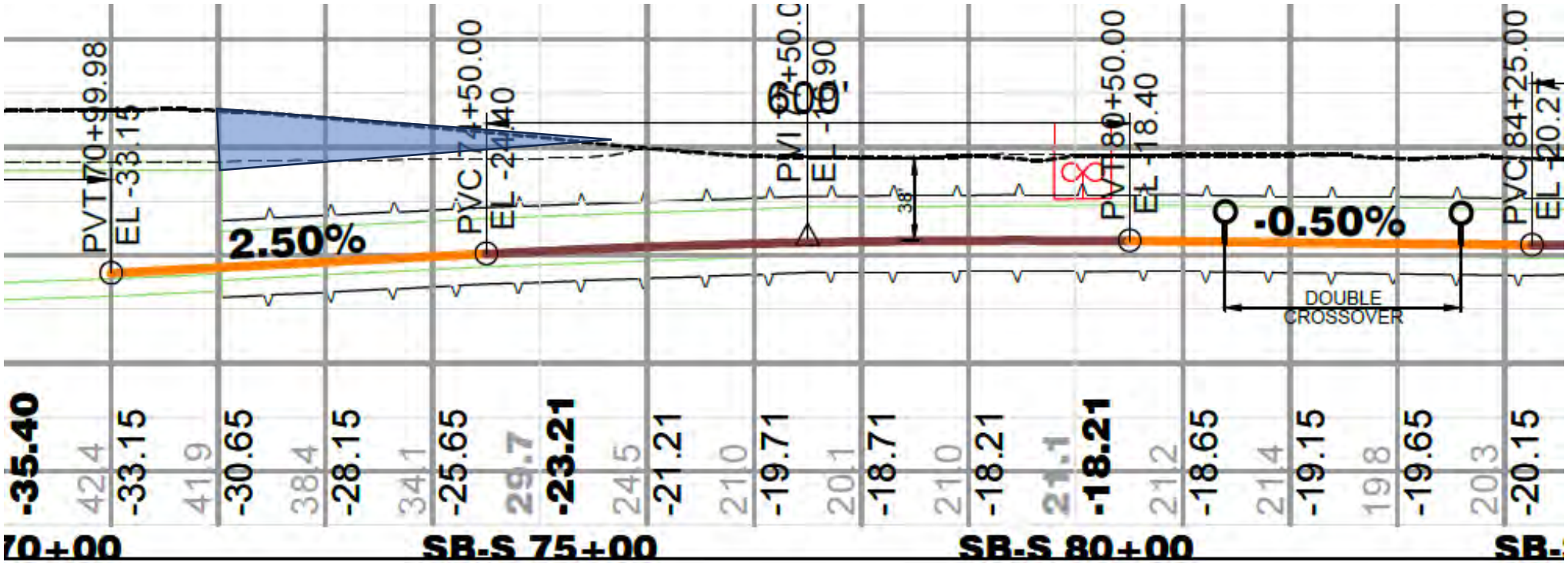
1. All lanes of 4th remain open to traffic



Ramp down to BNSF track level in Stage 2

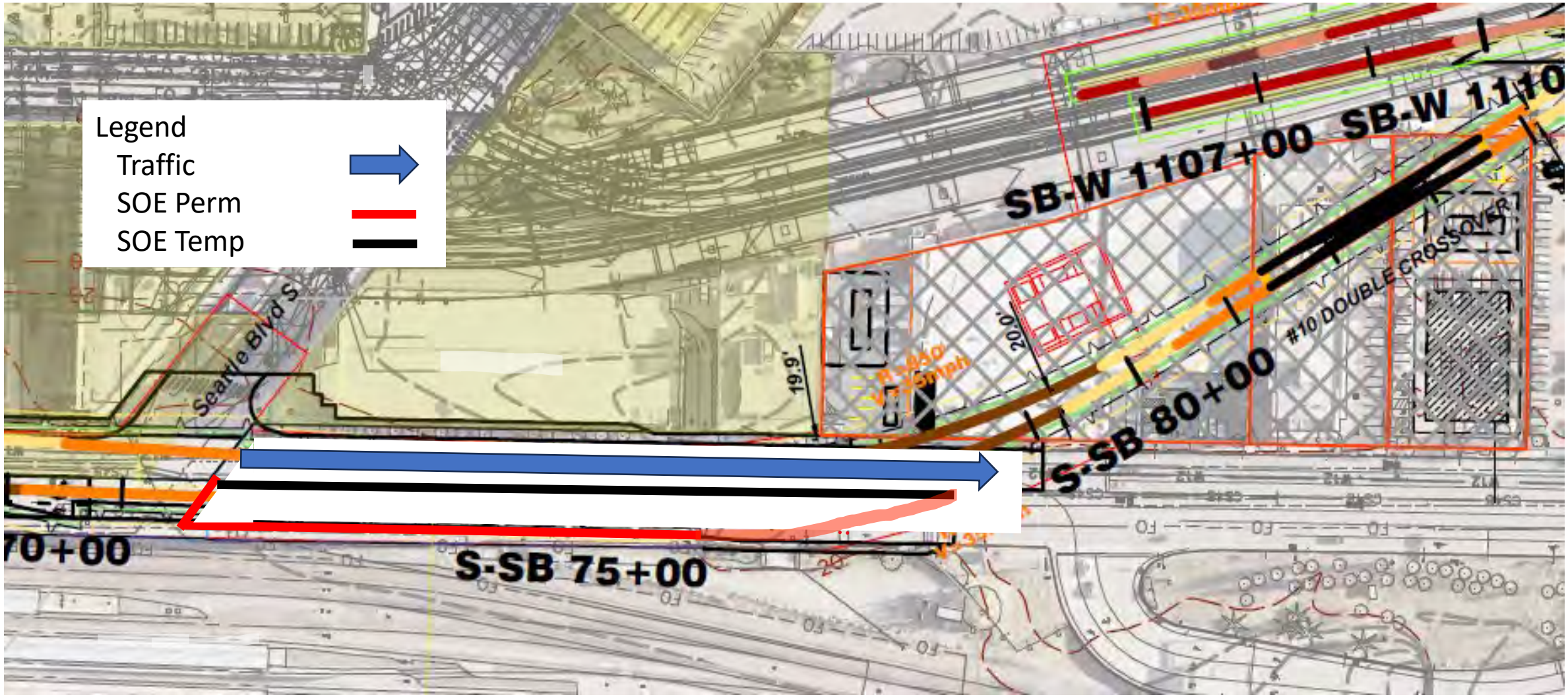


Ramp down to BNSF track level in Stage 2



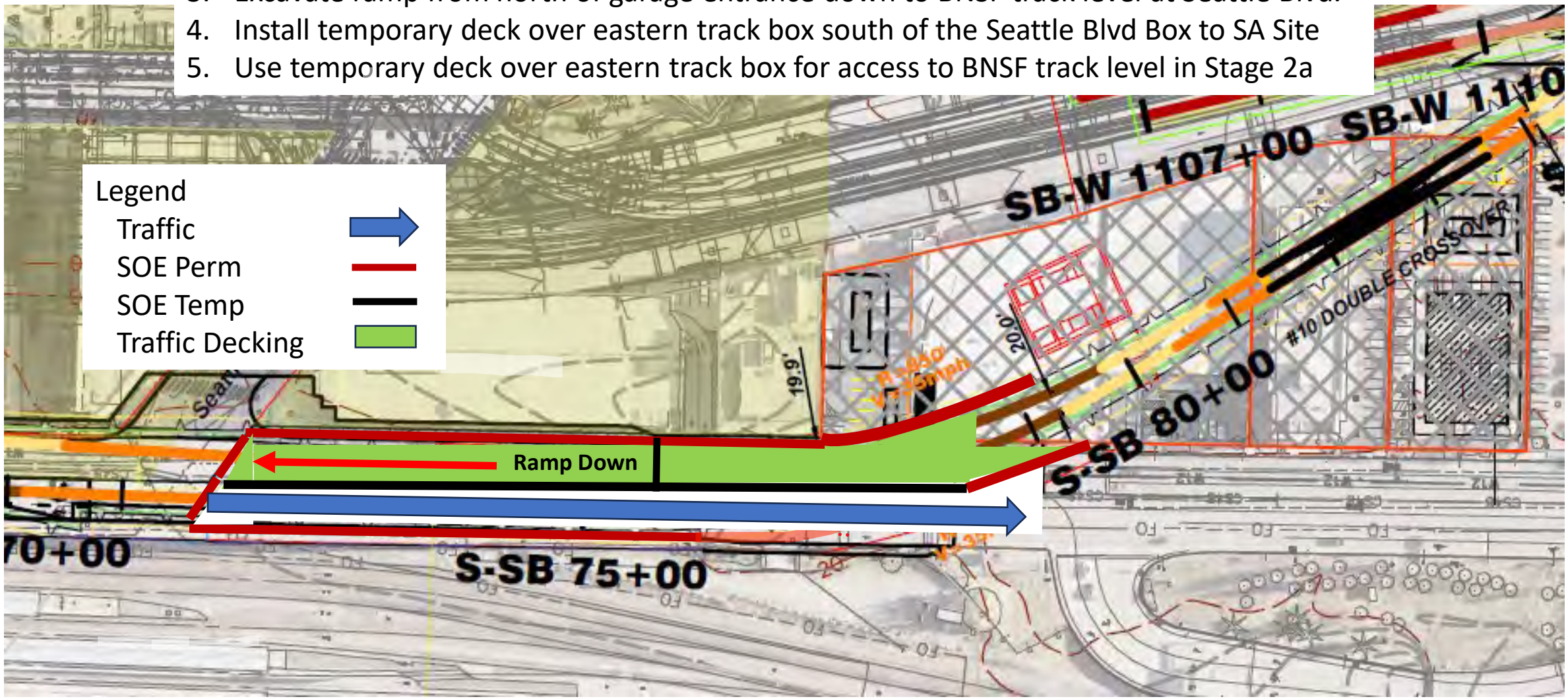
SOE West Side

1. Shift Traffic to East Side of 4th
2. Install permanent SOE for West (SP/SW) and center sheet pile wall



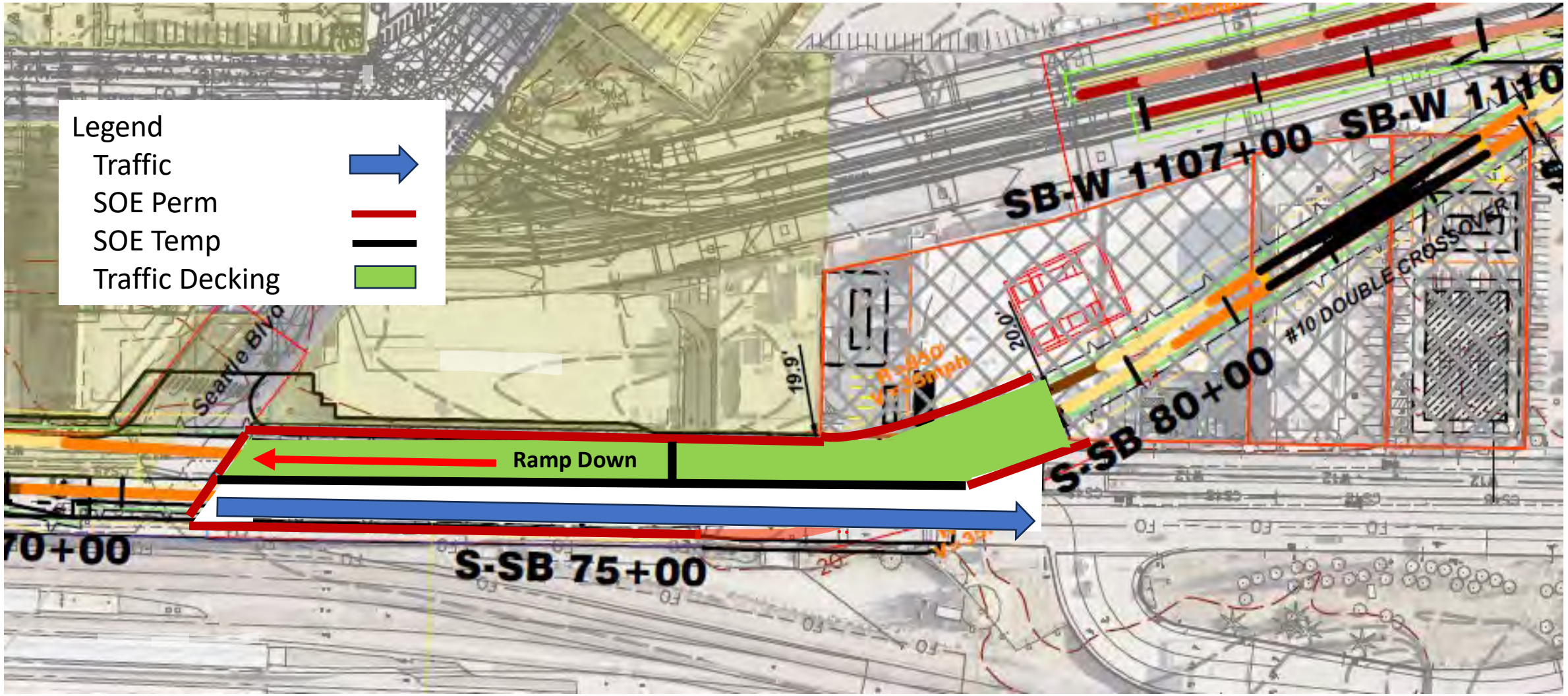
SOE East Side & Ramp to BNSF Track Level

1. Shift Traffic to West Side of 4th
2. Install permanent East SOE and remaining section of permanent West SOE (SP/SW)
3. Excavate ramp from north of garage entrance down to BNSF track level at Seattle Blvd.
4. Install temporary deck over eastern track box south of the Seattle Blvd Box to SA Site
5. Use temporary deck over eastern track box for access to BNSF track level in Stage 2a



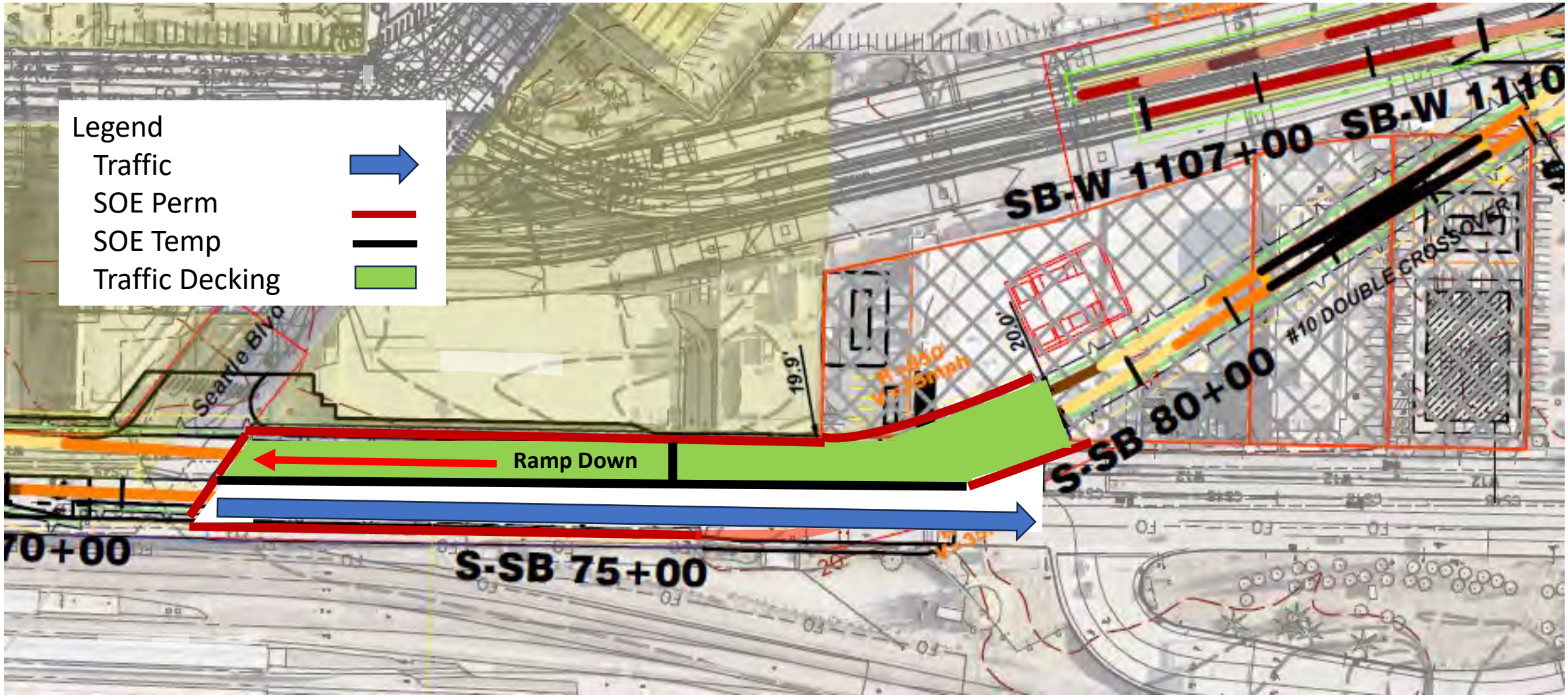
East Track Box Construction

1. Excavate / construct / backfill East Track Box + portion of West track box under the temporary decking on the east side of 4th Ave. Access from Salvation Army (SA) site.



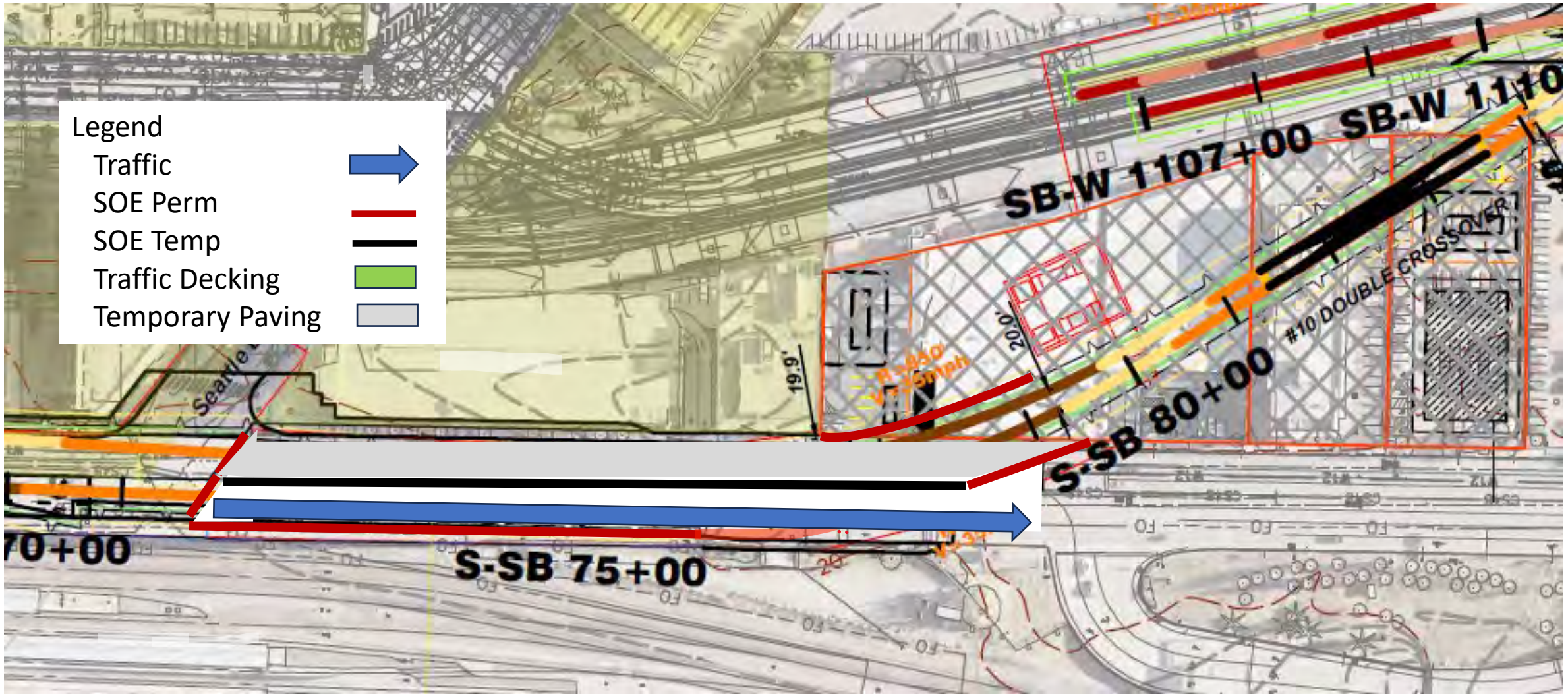
Construction of Track Boxes on SA site continues

1. Excavate / construct / backfill remaining East and West Track Box on SA site
2. Maintain ramp for access to work on 4th north of South Seattle Blvd. ROW line



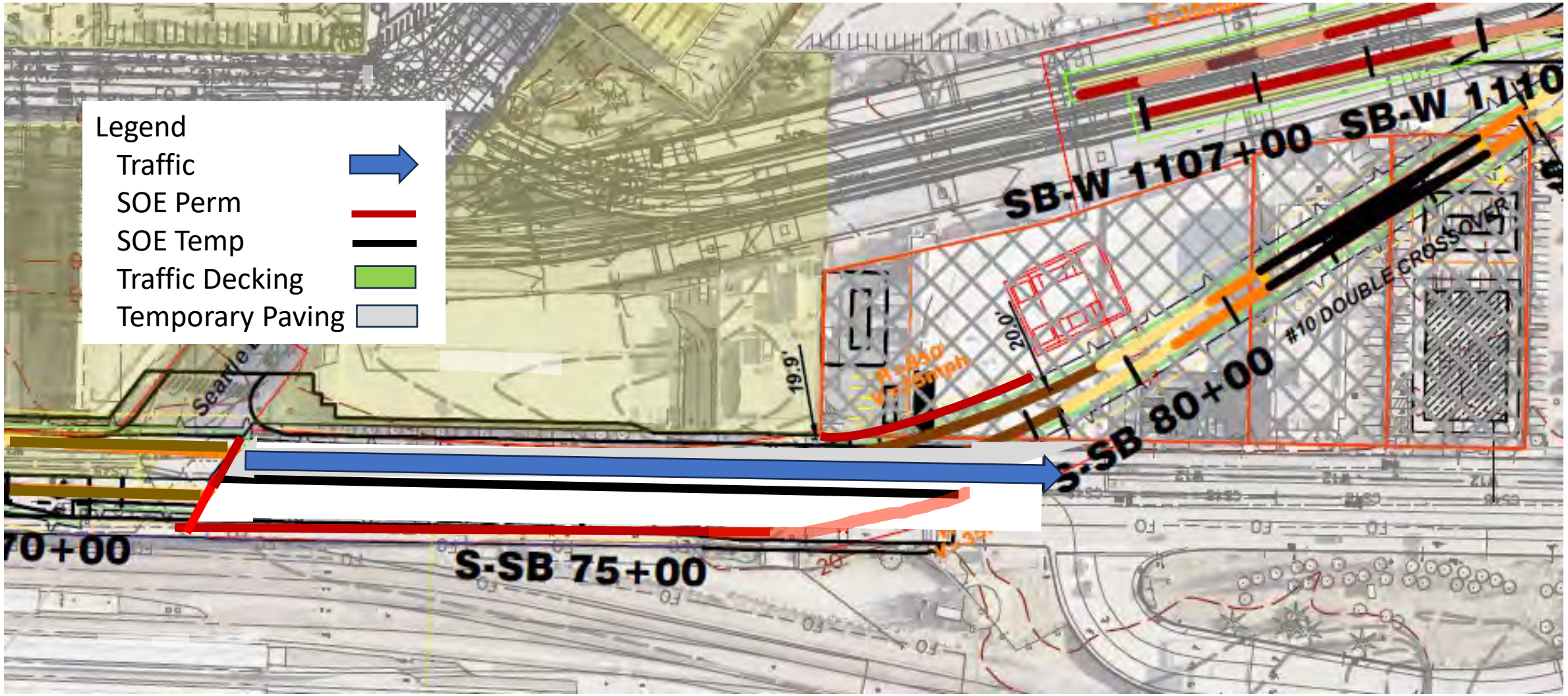
East Side Temporary Pavement

1. After ramp is no longer needed for access, remove temporary deck, complete backfill and install temporary pavement



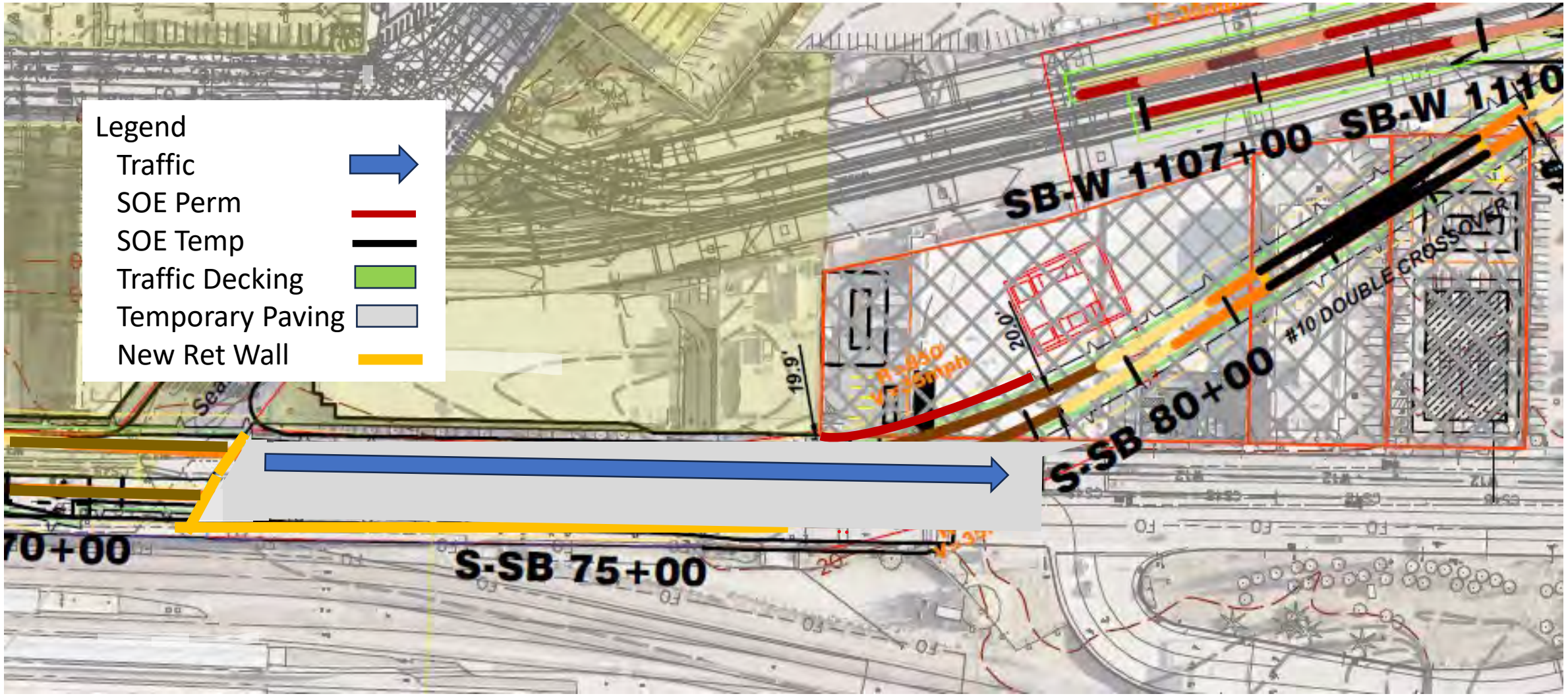
West Track Box Construction

1. Shift traffic to East side of 4th
2. Excavate / construct / backfill remaining portion of West Track Box within 4th Ave



West Retaining Wall Construction and Temporary Pavement

1. Construct permanent retaining wall on West
2. Finish backfilling and install temporary pavement



Open All Lanes of Traffic on 4th

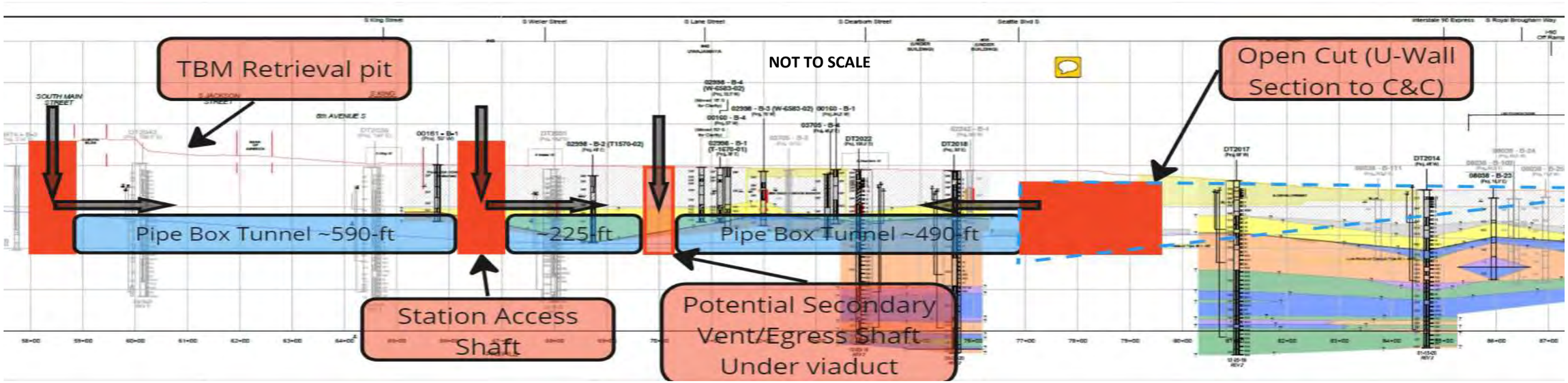


WSBLE 4th Shallow Option 3 Pipe Box

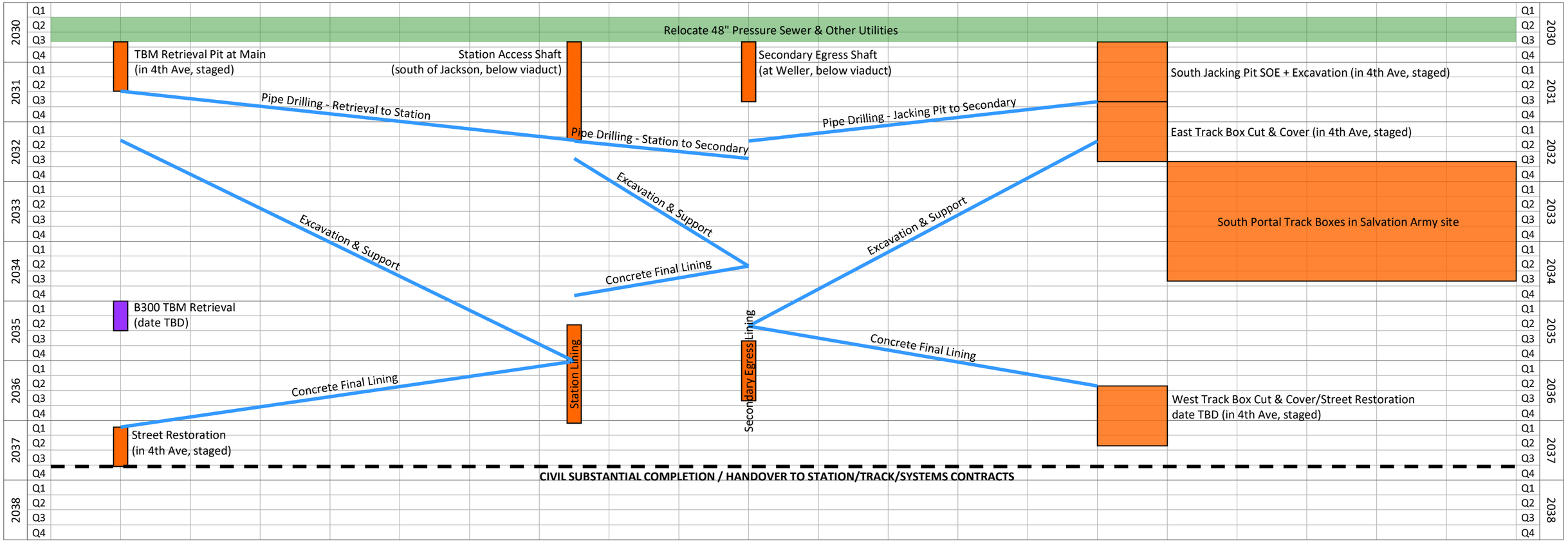
Conceptual schedule for brainstorming purposes only

DRAFT rev2

JRW 18-Aug-23



-100 0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000



GraphicSchedule.com

OPTION 3

Construct a pipe box tunnel under the 4th Avenue viaduct

Alternative Sketch

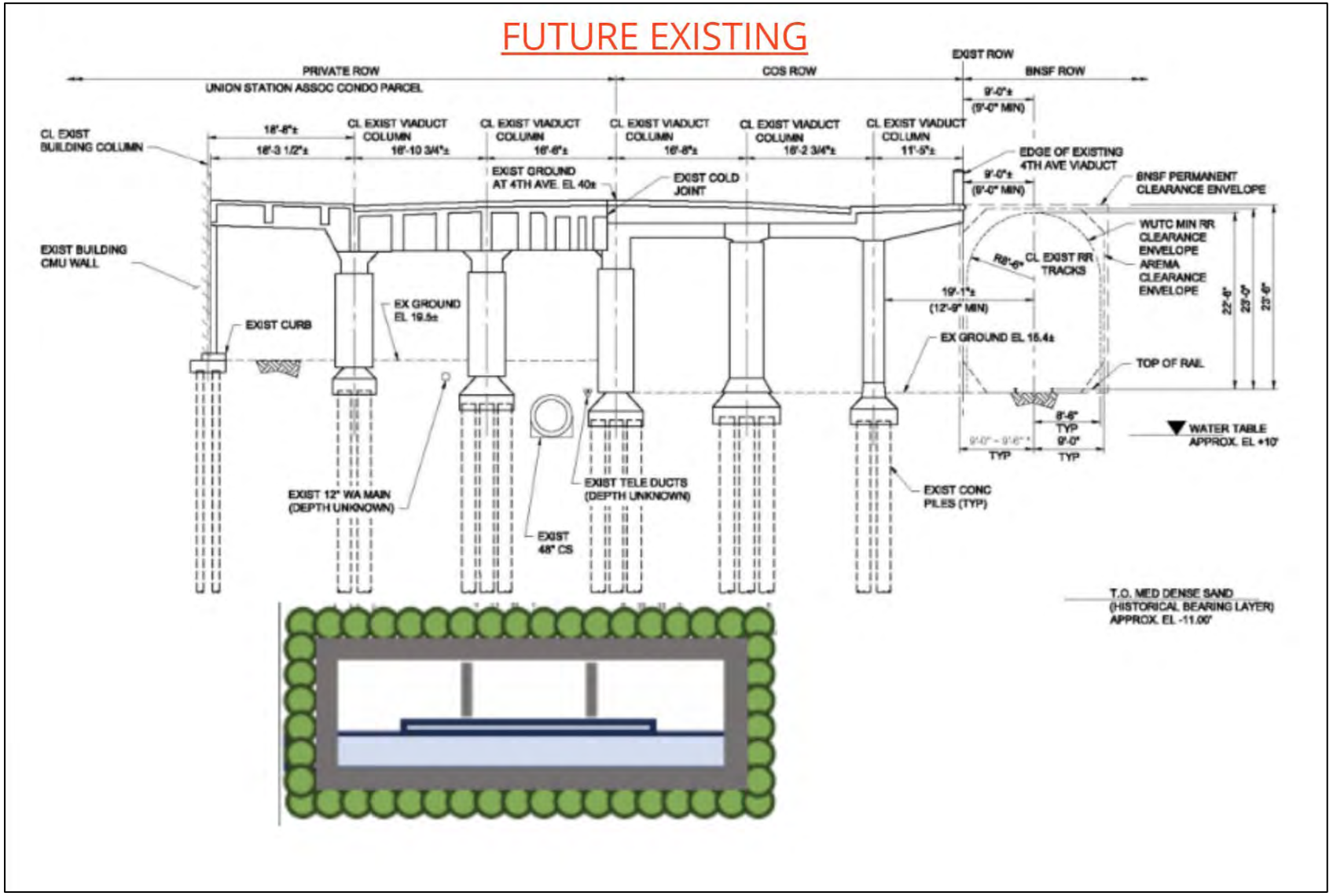


Traffic detour to accommodate temporary closure of 4th Ave. South

OPTION 3

Construct a pipe box tunnel under the 4th Avenue viaduct

Alternative Sketch

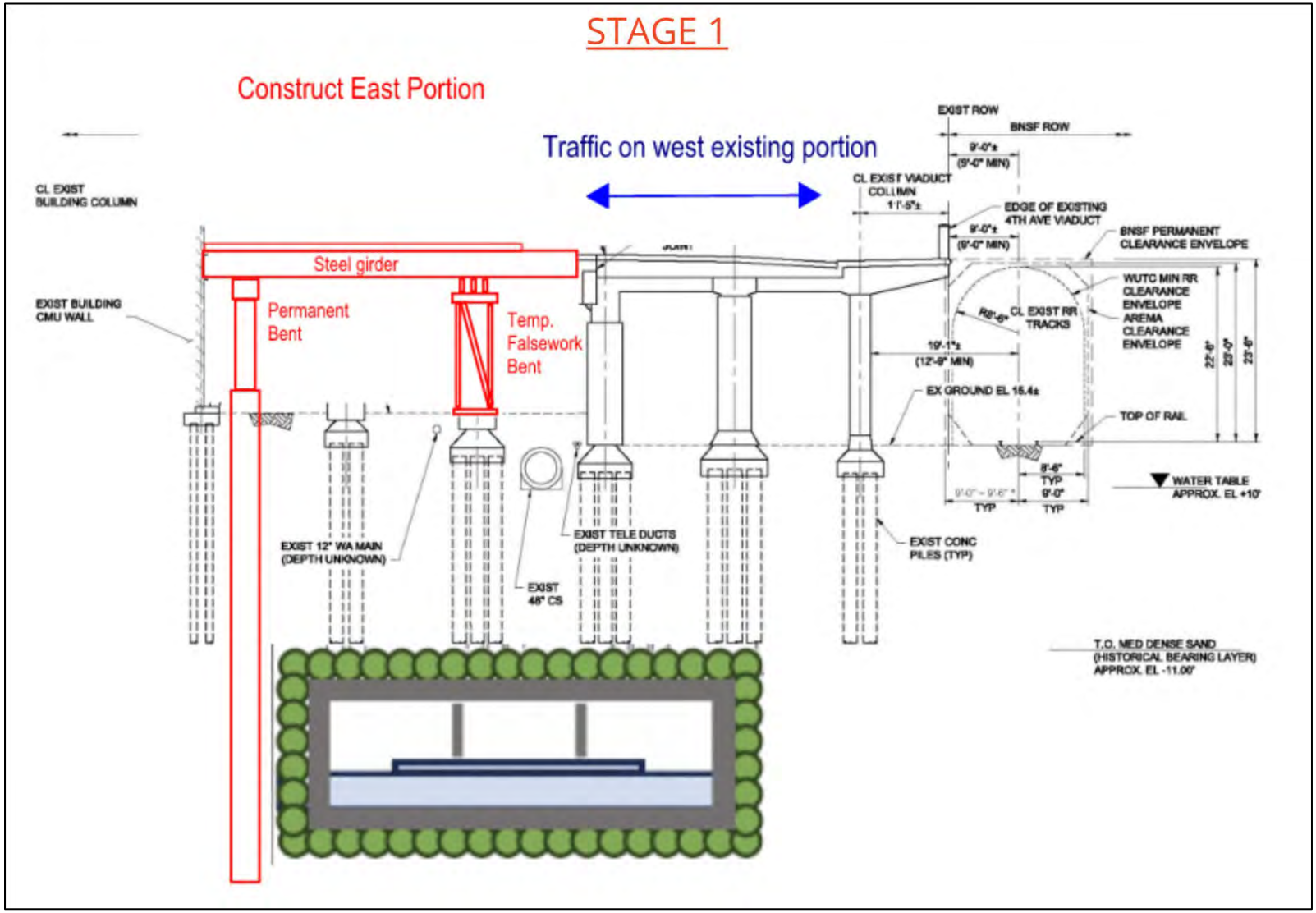


Future state of 4th Ave. viaduct after installation of pipe box tunnel

OPTION 3

Construct a pipe box tunnel under the 4th Avenue viaduct

Alternative Sketch

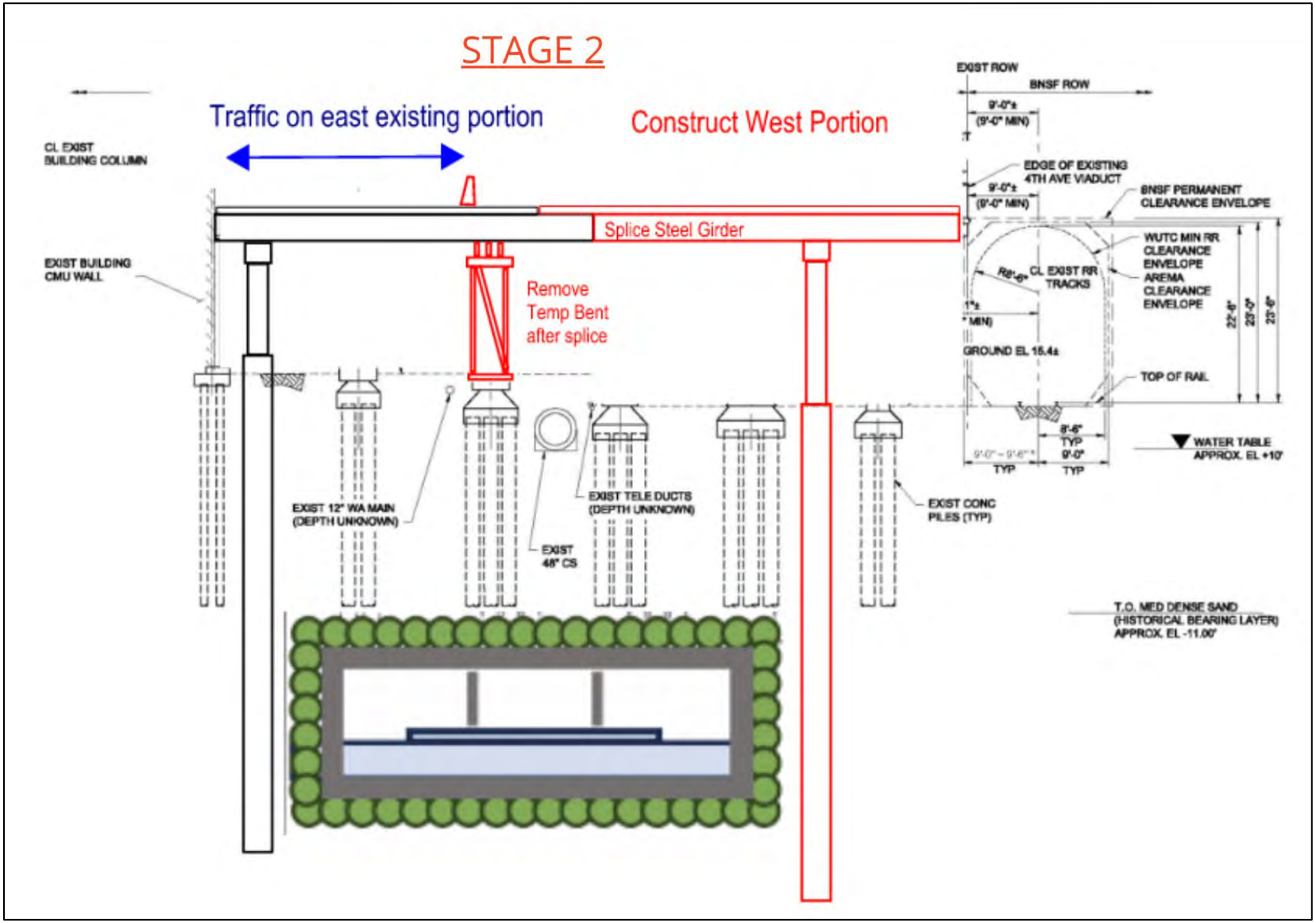


Stage 1 - Future replacement of the 4th Ave. viaduct

OPTION 3

Construct a pipe box tunnel under the 4th Avenue viaduct

Alternative Sketch

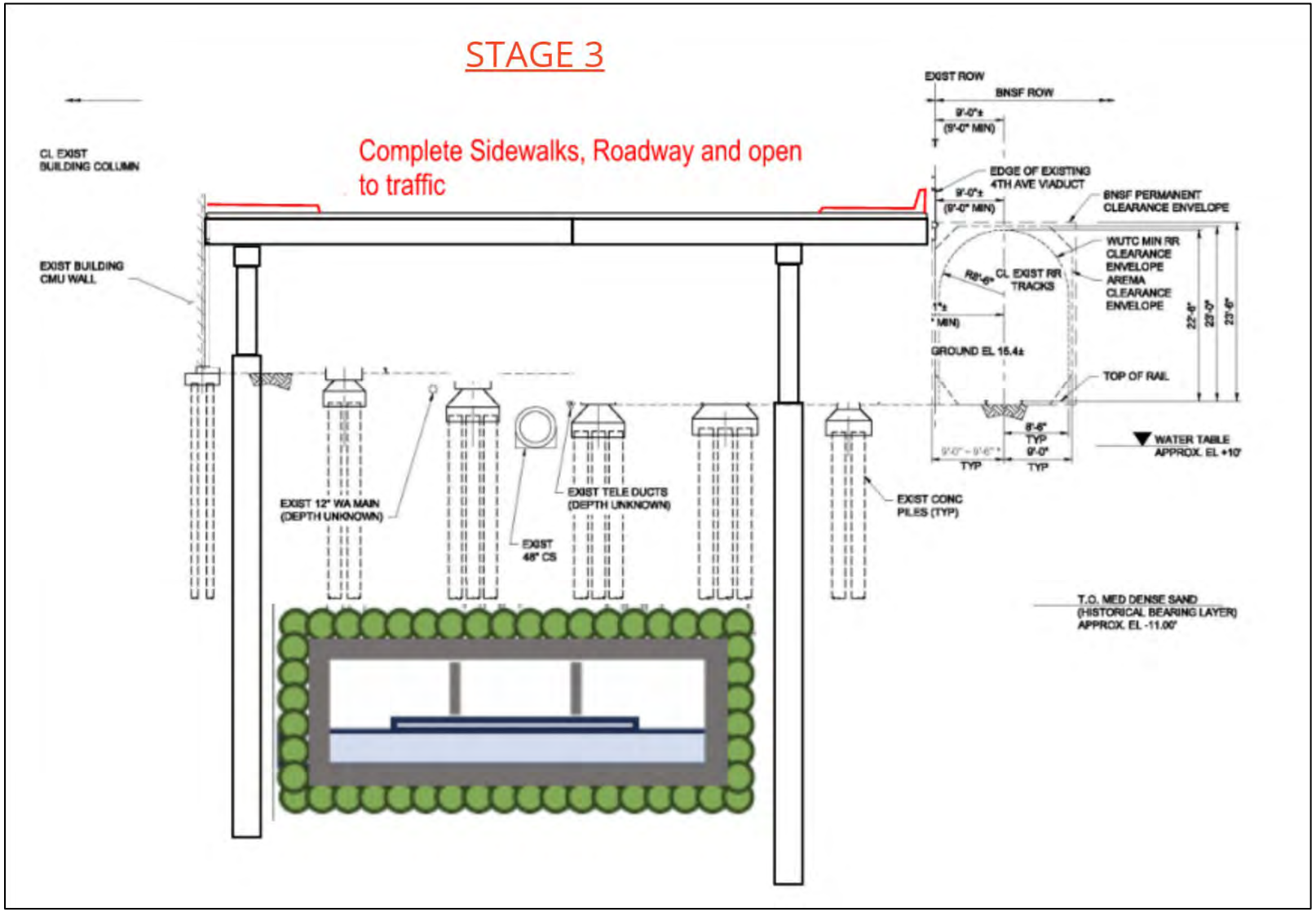


Stage 2 - Future replacement of the 4th Ave. viaduct

OPTION 3

Construct a pipe box tunnel under the 4th Avenue viaduct

Alternative Sketch

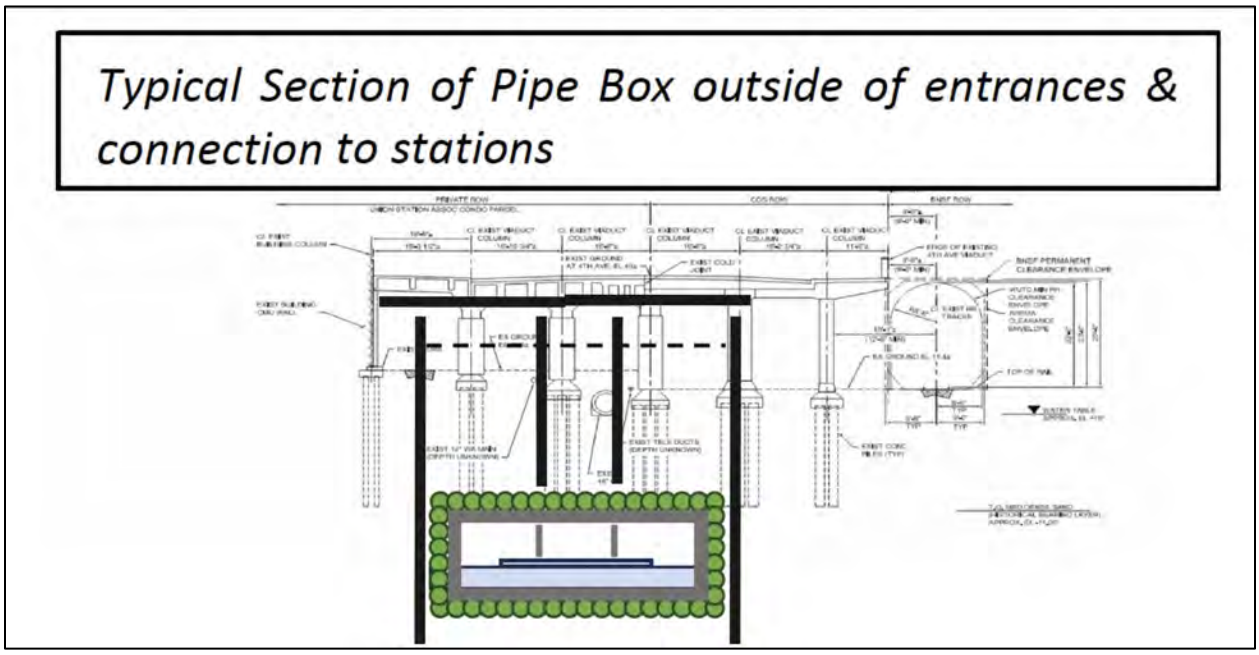


Stage 3 - Future replacement of the 4th Ave. viaduct

OPTION 3

Construct a pipe box tunnel under the 4th Avenue viaduct

Alternative Sketch



Typical section of pipe box tunnel (Option showing potential multi-column arrangement of future 4th Ave. viaduct replacement)

Gall Zeidler Consultants
Geotechnics | Tunnel Design | Engineering

111 John St. Suite 1270
New York, NY 10038
Phone: 646•480•4895
www.gzconsultants.com

MEMORANDUM

2471 MEM002 R00 Dr.docx

To: R. Stewart / Value Management Strategies, Inc. (VMS)

From: D. Reda / Gall Zeidler Consultants, LLC (GZ)

Cc: W. Klary / Gall Zeidler Consultants, LLC (GZ)

Subject: Additional Input for Option 3 Narrative

Reference: Salima Hamlin email dated 17-Aug-2023

Date: August 18, 2023

Responses to Initial Feedback on Option 3 (Pipe Box)

Feedback / Comment	Response
1. Related to preserving the viaduct with the triple vault and pipe box methods, we need to be mindful of the length of piles.	*While the triple vault is possible with ground improvement, the Pipe Box was progressed as an alternative because it is a more robust and risk managed approach for tunneling.*
2. Some of the piles as long as 75 ft according to know records; note that SDOT was not able to provide the pile tip elevations. The mined tunnel would cut through the timber and concrete piles.	*The approach is to avoid piles to the extent possible. Target would be for 2-3 between the end of the piles and above the top of the Pipe Box Structure. In the event that a pile is intersected during drilling, the impact from the drilling process is of low impact to the pile/viaduct. The concrete piles would pose a challenge of vibrating the liquifiable soils. In this case, we may need to have ground improvement at these locations. It would be localized, not expected for the entire length of the tunnel. Further to this, probing (horizontal drilling) can be performed at the locations of the piles to validate the pile depth prior to pipe installation. Overall, the drilling/impacts can be engineered and is not considered a fatal flaw.* *See also refinements for future studies.*
3. [The DEIS] station depth is 80' and putting the box below the viaduct footings could push the station down further.	*There is potential for lowering the TOR to accommodate the pipes and structural roof slab beneath the existing piles. Without a detailed study of pile depth and track alignment, a potential of a 5-10 ft drop from the DEIS TOR could be considered as part of the Option 3 study.*
4. The liquefiable soils in this area.	*The approach would be to avoid piles to the extent possible, and therefore, also be within the Recent Glacial Deposits and the Glacial Deposits. In areas where the liquefiable soils cannot be avoided, ground improvement (DSM or Jet Grouting) can be implemented. Again, it would be localized, not expected for the entire length of the tunnel. It can be engineered and not considered a fatal flaw.*
5. At the depth shown in the section, the majority of the	*We have been using the North CID and South CID*

SEM tunnel, except at the northern end, will be located in liquefiable soil resulting in substantial ground improvement	*geologic profile as the basis, and currently consider the top of pipes just under the liquefiable soils. If the 4th Ave geologic profile becomes available, the Option 3 graphics can be updated accordingly.*
6. [The previous] 4th deep option which was the mined option, resulted in a station depth of 190'.	*Without knowing the details of the deep SEM Option, I suspect that the cavern size is in accordance with other mined SEM Stations for WSBLE (~65-ft diameter). To reduce impact and to mine within more competent ground, it is not unusual for the depth of the SEM cavern to be ~190'. However, one must keep in mind that the Pipe Box presented in Option 3 does not follow the same excavation profile of the large SEM Cavern, nor the approach for tunneling. For Option 3, the concept relies on the Pipe Box (pre-support) to provide a controlled and risk managed approach to build the tunnel structure within. The goal is to avoid impacting the piles and ergo, the liquefiable soils.*
7. Consideration for the pipe box could be vibration and construction effects on the existing viaduct and also future accommodation to replace the viaduct.	*See also above for vibration during construction. There is industry precedence to estimate vibrations induced during construction. This can be engineered and is a manageable risk. With regards to the future accommodation to replace the viaduct, Option 3 includes a concept to reasonably replace the viaduct in the future.*
8. Seismic interaction needs to be considered between the tunnel lining and viaduct piles.	*Correct, and this would have to be considered in detail during future studies. Further to this, we would have to evaluate the vibration induced from train operations. The concept considers a floating track slab or similar measure would be in place to limit vibrations during operations. Overall, seismic interaction can be engineered and is not considered a fatal flaw.*

Considerations / Refinements for Future Studies

1. Station Access Shaft: A T-shaped shape may better accommodate staircases/escalators down to platform elevation.
2. Track Alignment: Review Option 3 in more detail to optimize the track alignment to avoid viaduct piles.
3. Station Configuration: Option 3 considers the Station Access Shaft more towards the north side of the platform. If the platform is centered at the Station Access Shaft, time from surface to each end of the platform would be equal.
4. Emergency Egress: in lieu of an exit to the street surface, the running tunnel pipe box can include an emergence egress corridor to an emergency egress at a repurposes TBM Launch Pit (at South Main) or Jacking Pit (just south of Seattle Blvd.)
5. Ventilation Design: potential repurpose of TBM Launch Pit (at South Main) or Jacking Pit (just south of Seattle Blvd.) as part of the ventilation design for CID Station.
6. Secondary Station Access Shaft at Weller Street: Review of a secondary access from the street to accommodate functional station requirements.
7. Side Platform Station Configuration: This configuration would help reduce the width of the Pipe Box, which leads to less impact, risk, cost, and better production rates.
8. Individual Running Tunnels: The running tunnels between the Station Access Shaft and the TBM Launch Pit (at South Main) / Jacking Pit (just south of Seattle Blvd.) can be individual tunnels in lieu of matching the DEIS concept. Individual tunnels would help reduce less impact, risk, cost, and schedule.

ICON BUILDING

Strategies for Mitigating Impacts to the Icon Building

Overview: The workshop team came up with several strategies to maintain access to the Icon apartment building during the reconstruction of the 4th Ave. viaduct structure. The current concept assumes that residents of the apartments will need to be temporarily relocated for a 2-month period on two separate occasions due to the loss of access to both the main entrance and the driveway along 4th Ave. The strategies that were considered include the following:

Develop a temporary (or permanent) entrance off Jackson St.

- Much of the first floor of the Icon building along Jackson St. is vacant retail space (formerly occupied by Bartell's Pharmacy). A new entrance could be developed by performing tenant improvements within the building with the purpose of connecting the current lobby off 4th Ave. to the retail entrance located on Jackson St. This appears to be a relatively inexpensive modification that could also provide pedestrian and bike access for residents.

Develop a temporary access ramp from South Main St. to service yard.

- There is a small service yard and parking area serving the Icon building that is accessed via a vehicle entrance off 4th Ave. It would be possible to develop a temporary ramp approximately 100-feet long at a 10-12% grade to facilitate vehicle access to the service yard. This would support maintenance and garbage removal and possibly resident access to their parking area. South Main St. appears to be 10-12 feet higher than the grade of the service yard.

Develop a temporary vehicle lift with access from South Main St. to service yard.

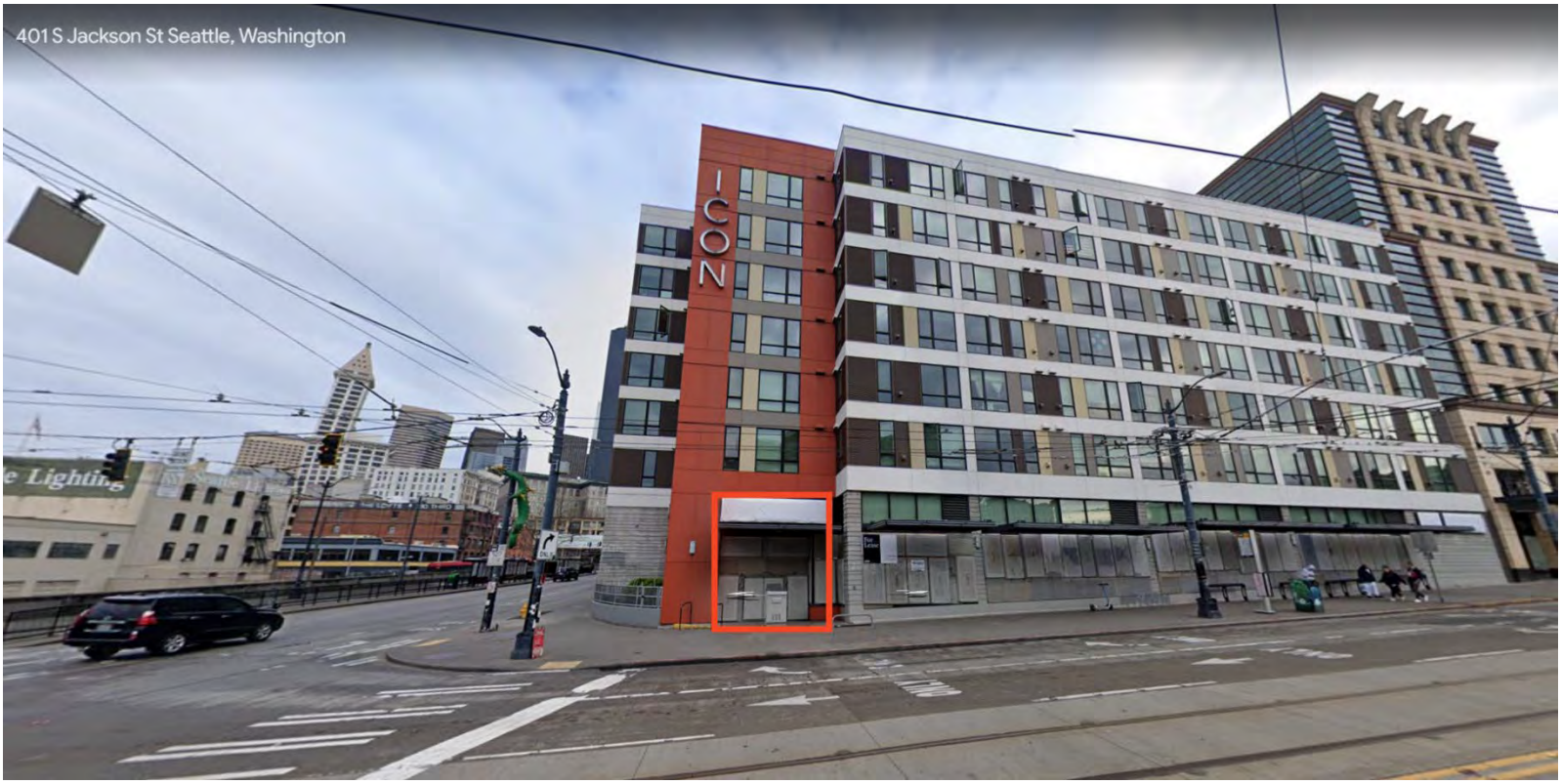
- There is room to install a temporary vehicle lift to allow access for service/maintenance vehicles to access the service yard.

Explore developing access to service yard or underground parking via adjacent building underground parking.

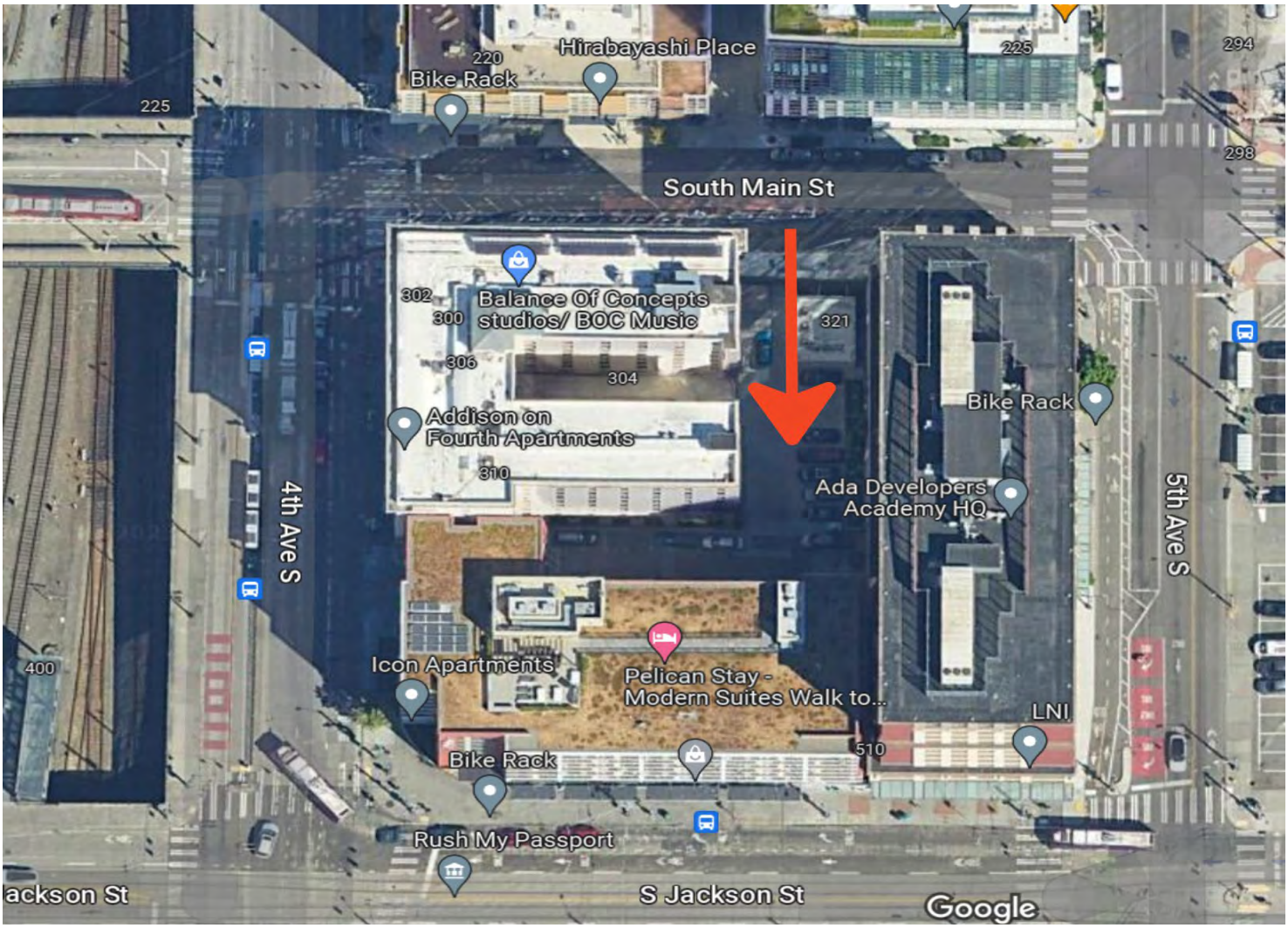
- The two adjacent buildings located on South Main St. (the Addison on Fourth Apartments and 315 5th Ave. building) have underground parking garages that could potentially have levels close to the same elevation as the service yard. It may be possible to develop temporary access to the service yard through one of these buildings.
- Additionally, the Union Station parking structure extends under Jackson and likely comes into proximity, if not adjacency, to the Icon building's underground lot. It is recommended to explore whether a connection could be made between these two structures for resident vehicle access or as another method of accessing garbage and/or service vehicles.

ICON BUILDING

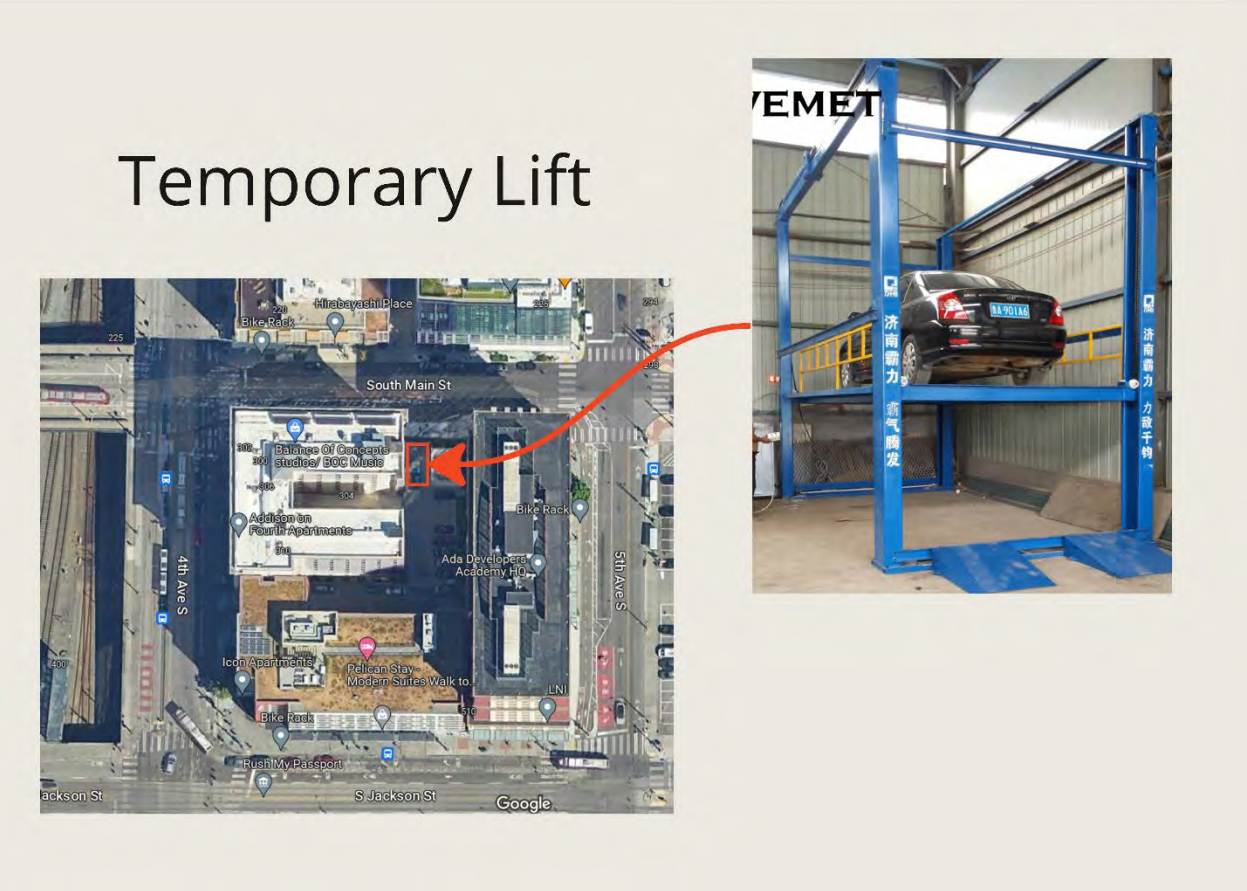
Strategies for Mitigating Impacts to the Icon Building



Develop new entrance on South Jackson St.



Temporary ramp



Temporary lift example

NORTH AND SOUTH OPTION 1

Construct side platforms at North of CID Station and adopt Bellevue Tunnel cross-section for crossover

Overview: This concept would adopt a reduced cross-section, like what was used for the Bellevue Tunnel, to reduce the amount of excavation and mining required at the North CID Station. Side platforms would be required; however, a connecting mezzanine would be constructed above to facilitate passenger circulation between/with the Pioneer Square Station. Consequently, this would reduce the amount of mining for the crossover cavern at CID North.

Constraints:

- Crossover track length based on side platform configuration (currently assumes the same length as center platform; it is needed to determine if final length of crossover with closer centers i.e., for side platform station).
- Maintaining DEIS track configuration, alignment, and TOR (top of rail).

Geotechnical Considerations:

- Entire station and crossover will be within the glacial deposits.
- Boulders are potential in glacial deposits; standard SEM (Sequential Excavation Method) tunneling in Seattle is to be removed when encountered.
- Regional GWT (groundwater table) well below SEM crossover; there is a need to account for perched groundwater. Toolbox items for ground improvement dependent on geological conditions is needed.

Potential Effects & Mitigations:

- Less effects to main elements includes BNSF tunnel and adjacent buildings (City Hall).
    - Industry practices for settlement analysis and vibrations from construction and operation.
    - Pipe arch canopy above tunnel crown(s) for turning under at portal.
    - Robust solution would be ground freezing (need to consider freeze-thaw effects).

Constructability Considerations:

- Excavation in one direction from the station toward the TBM (tunnel boring machine) retrieval shaft.
- Shaft construction/MOT (maintenance of traffic) is per the current DEIS concept.

Schedule Benefits:

- Single Cell at 300 feet long approximated 4-5 months for SEM excavation (excluded final lining).

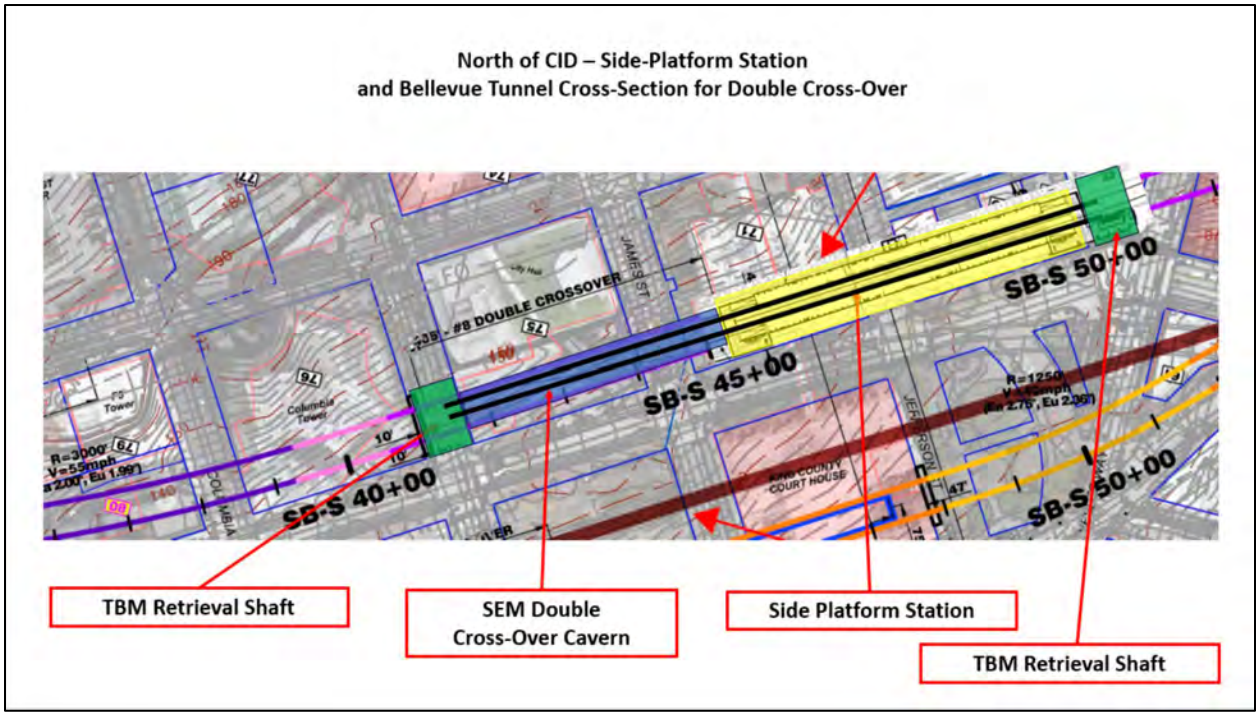
NORTH AND SOUTH OPTION 1

Construct side platforms at North of CID Station and adopt Bellevue Tunnel cross-section for crossover

Cost Benefits:

- Substantially cheaper and faster than the large cavern SEM as proposed in documents provided to the SA team.

Project Image

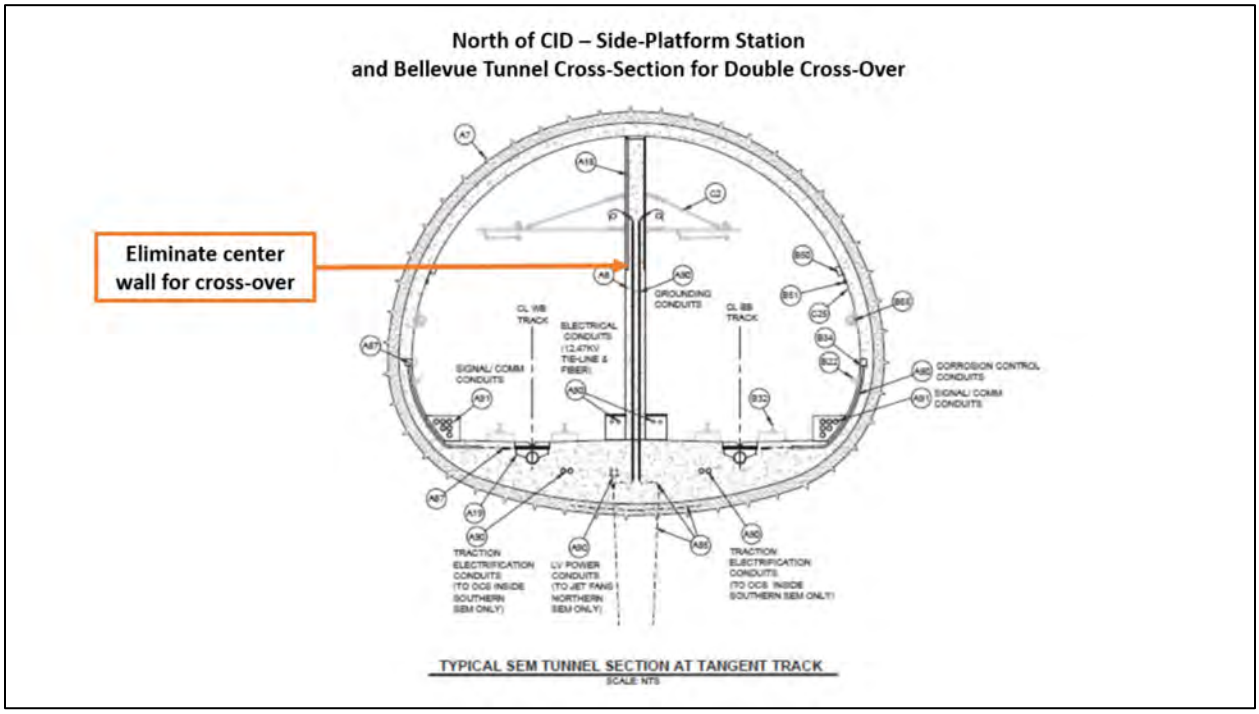


Proposed Concept – Plan view

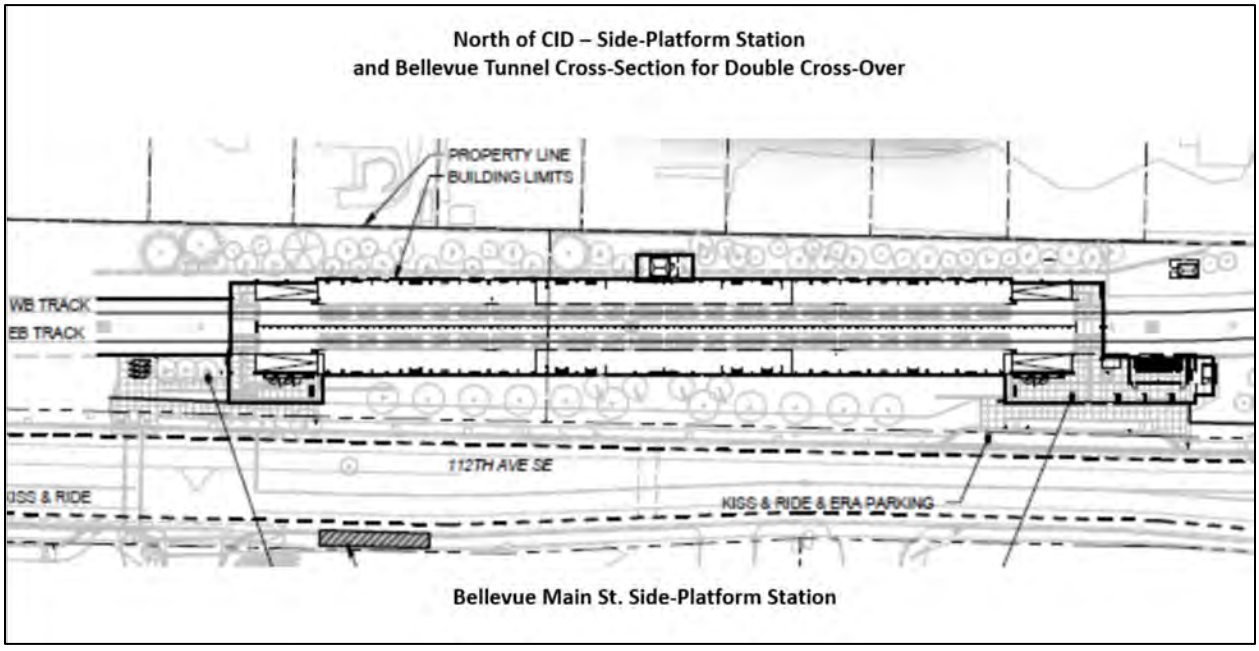
NORTH AND SOUTH OPTION 1

Construct side platforms at North of CID Station and adopt Bellevue Tunnel cross-section for crossover

Project Images



Section View of Bellevue Tunnel

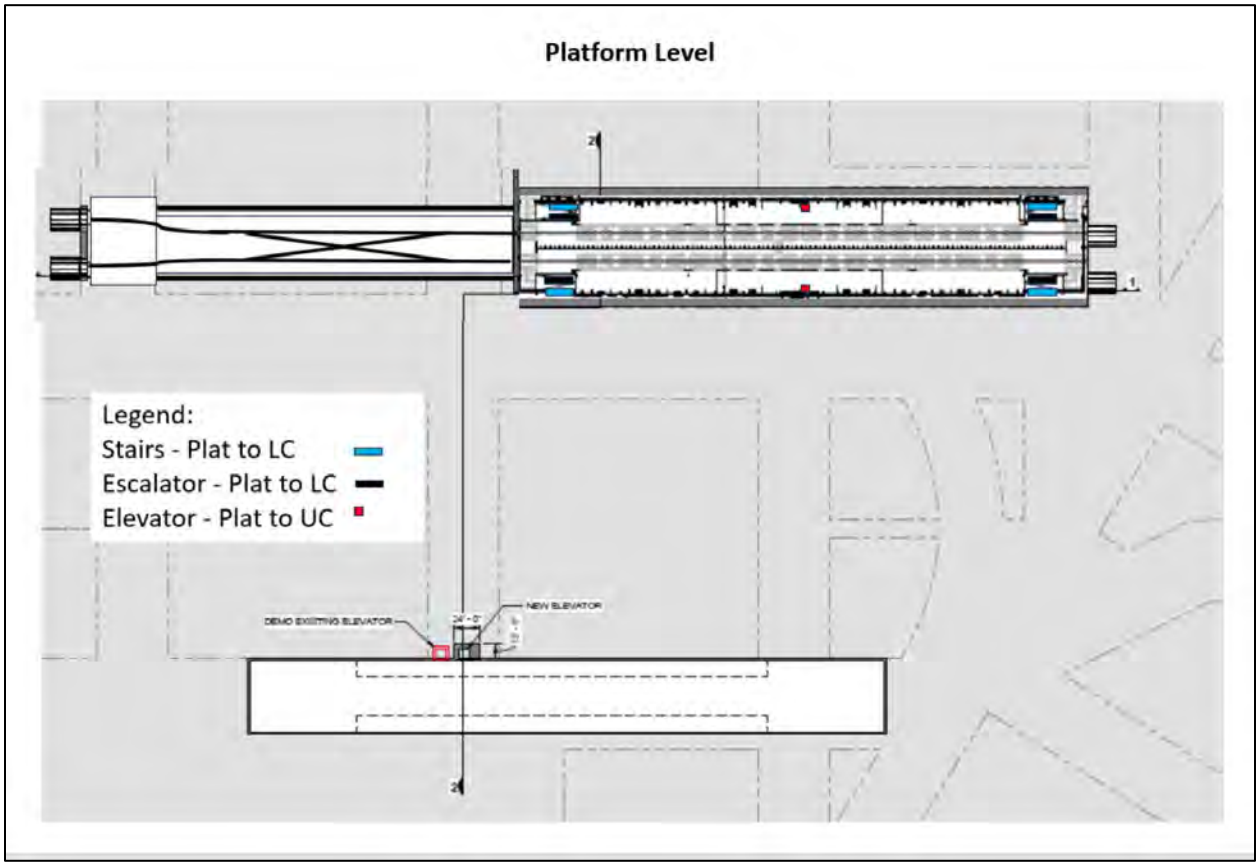


Plan View – Proposed station layout

NORTH AND SOUTH OPTION 1

Construct side platforms at North of CID Station and adopt Bellevue Tunnel cross-section for crossover

Project Image

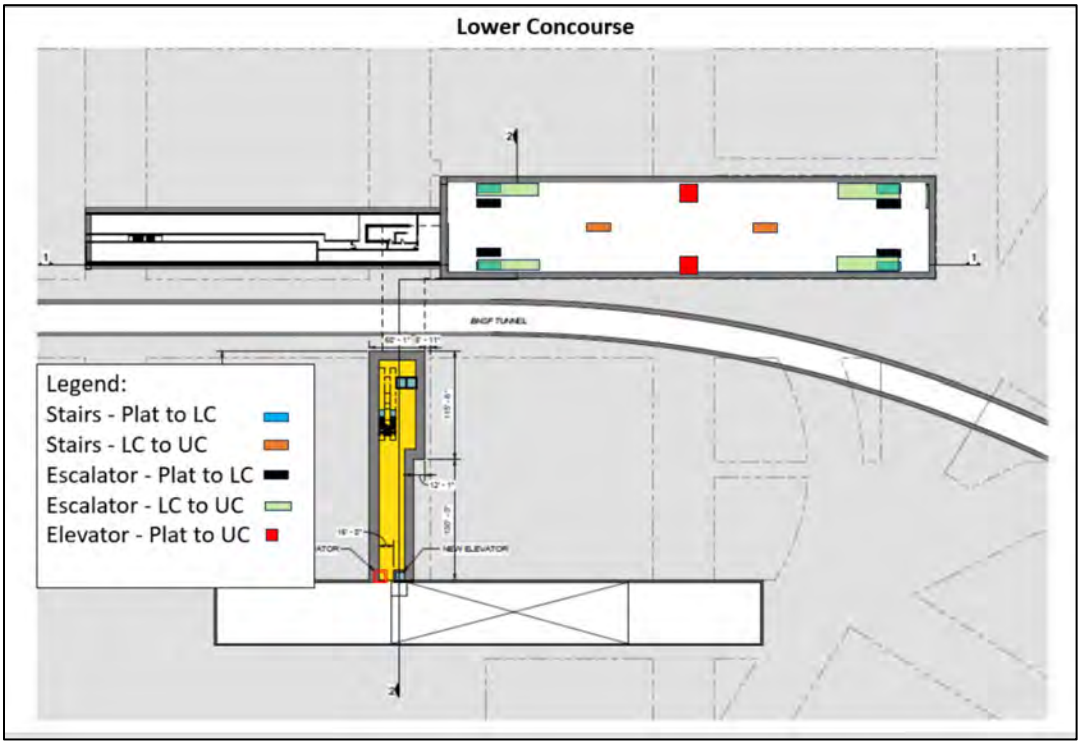


Platform Level Layout – Proposed Concept

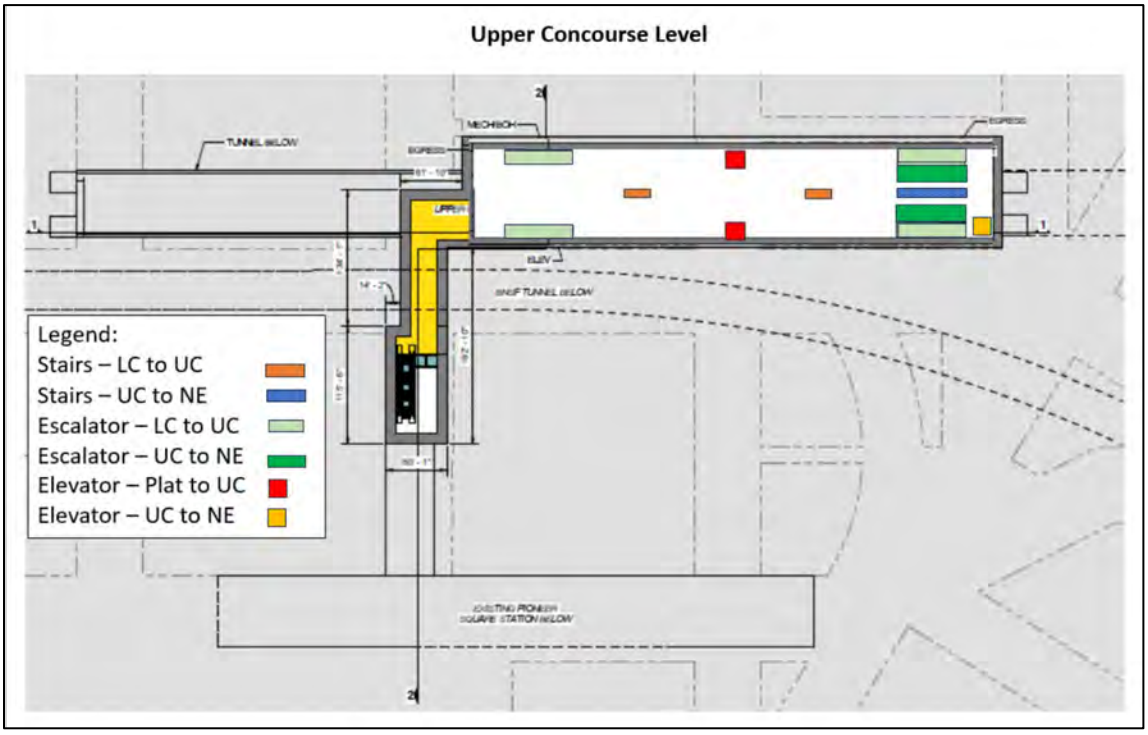
NORTH AND SOUTH OPTION 1

Construct side platforms at North of CID Station and adopt Bellevue Tunnel cross-section for crossover

Project Images



Lower Concourse Level Layout – Proposed Concept

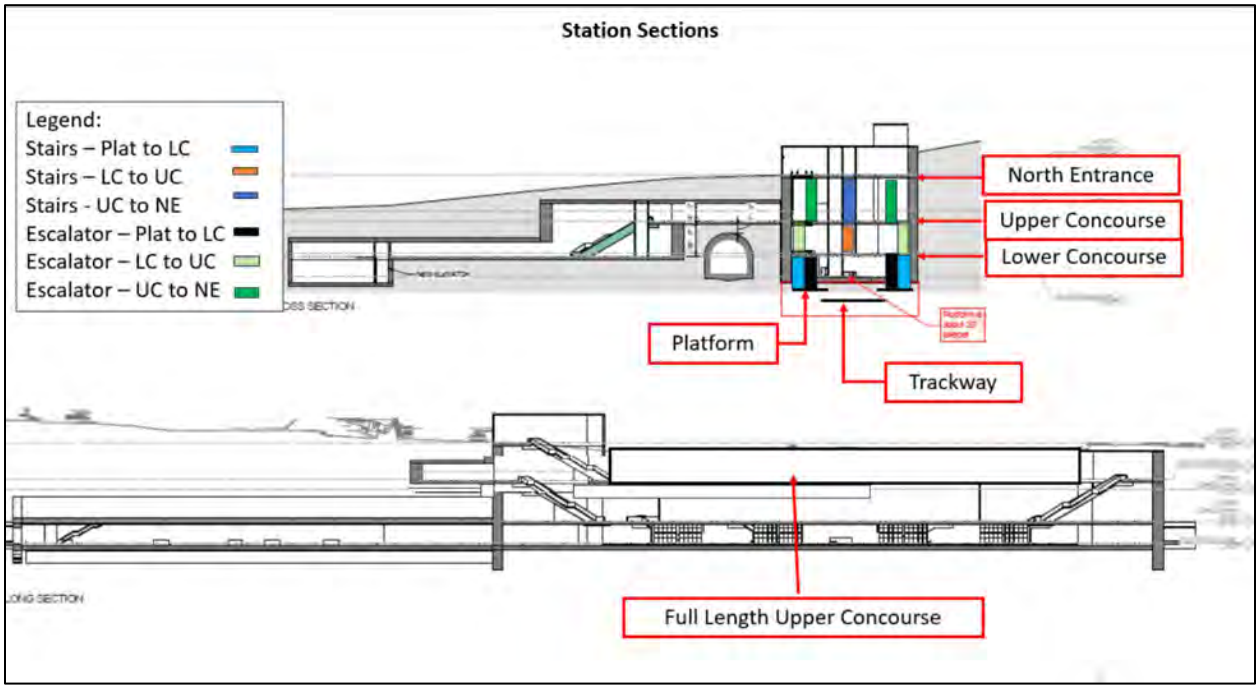


Upper Concourse Level Layout – Proposed Concept

NORTH AND SOUTH OPTION 1

Construct side platforms at North of CID Station and adopt Bellevue Tunnel cross-section for crossover

Project Image



Station Section – Proposed Concept

NORTH AND SOUTH OPTION 2

Construct center platform at North of CID Station and use triple cell SEM crossover

Overview: This concept would use a triple cell cross section to reduce the volume of mining required at the North CID Station. This concept assumes the construction of a center platform station (like Option 1); however, this could be configured for a center platform as well. With side platforms, a connecting mezzanine would be constructed above to facilitate passenger circulation between/with the Pioneer Square Station.

Constraints:

- Crossover track length based on side platform configuration (currently assumes the same length as center platform). Final length of cross-over with closer centers i.e. for side platform station needs determination.
- Column support elements to be designed around trackwork and train envelope.
- Maintaining DEIS track configuration, alignment, and TOR.
- GWT to be maintained during all construction activities (mainly perched groundwater).

Geotechnical Considerations:

- Elevation for top of crossover aimed to be within the glacial deposits.
- Boulders are potential in glacial deposits. Standard SEM tunneling in Seattle is to remove boulders when encountered.
- Regional GWT well below SEM crossover; an account for perched groundwater is needed. Toolbox items for ground improvement dependent on geological conditions is needed.

Potential Effects and Mitigations:

- Less effects to main elements includes BNSF tunnel and adjacent buildings (City Hall).
    - Industry practices for settlement analysis and vibrations from construction and operation.
    - Pipe arch canopy above tunnel crown(s) for turning under at portal.
    - Robust solution would be ground freezing (need to consider freeze-thaw effects).

Constructability Considerations:

- Assuming pipe arch canopy, establishing the sawtooth profile.
- Excavation in one direction from the station toward the TBM retrieval shaft.
- Connection at the interface between cells.
- Shaft construction/MOT is per the current DEIS concept.

NORTH AND SOUTH OPTION 2

Construct center platform at North of CID Station and use triple cell SEM crossover

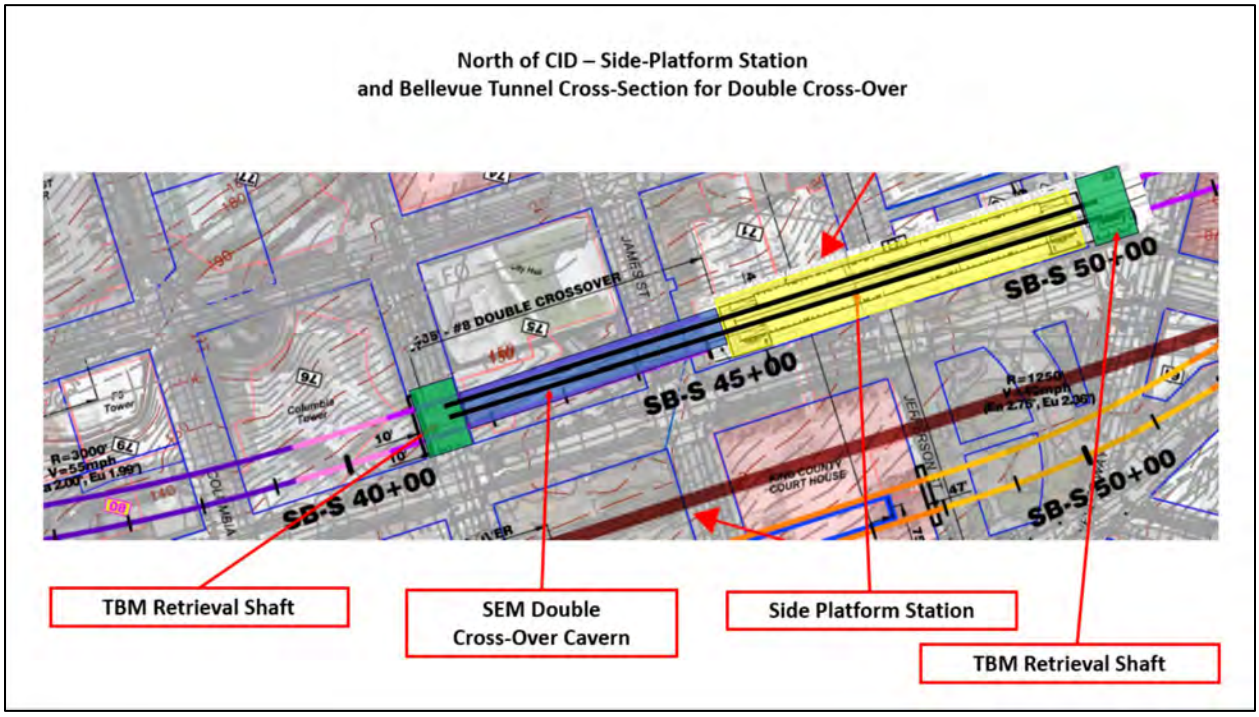
Schedule Benefits:

- Triple Cell at 300 feet long approximated 8-9 months for SEM excavation (excluded final lining).

Cost Benefits:

- Substantially cheaper and faster than the large cavern SEM as proposed in documents provided to the SA team.

Project Image

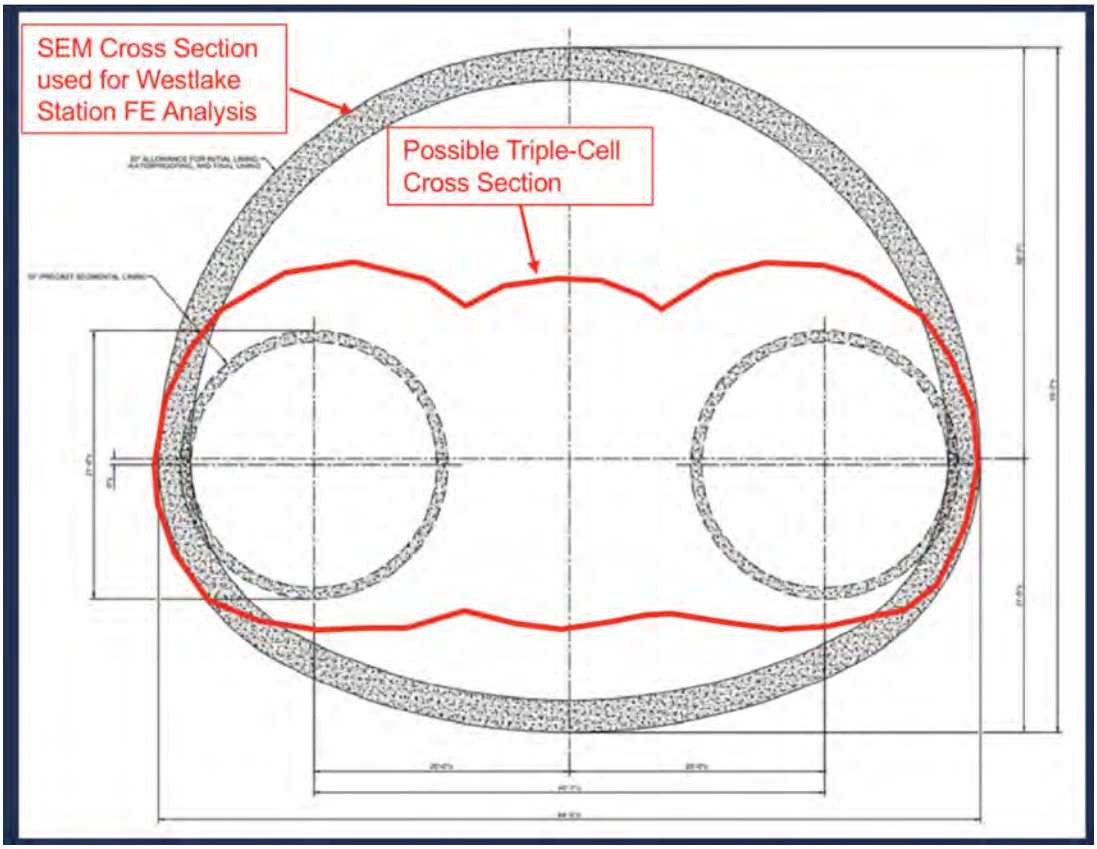


Proposed Concept – Plan View

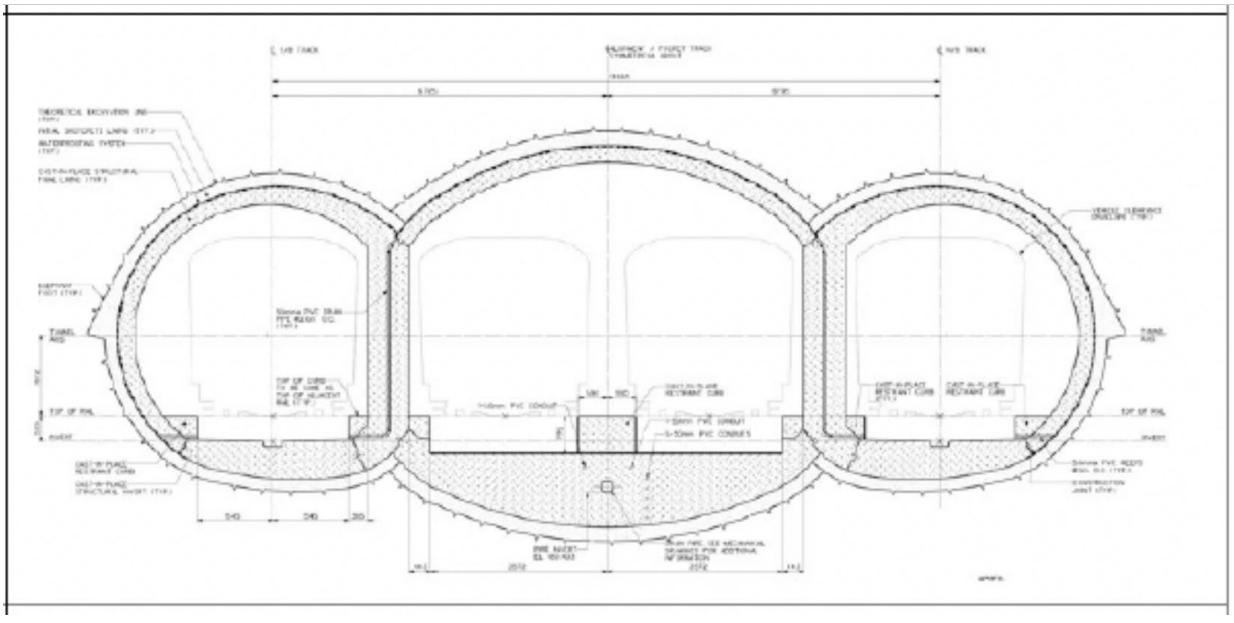
NORTH AND SOUTH OPTION 2

Construct center platform at North of CID Station and use triple cell SEM crossover

Project Images



Section View of Westlake Station used for analysis



Triple-Cell Cross Section used for TTC – Toronto-York Spadina Subway Extension

PROJECT INFORMATION

PROJECT INFORMATION

BACKGROUND

The latest version of the 4th Ave. Shallow Alignment alternative is illustrated in Figure 1. The segment begins at the tunnel portal located roughly adjacent to Stadium Station and runs north under 4th Ave. South with a new station located roughly adjacent to the existing Chinatown/International District Station. The alignment for this segment would continue north, eventually merging back onto 5th Ave. with a station at Midtown.

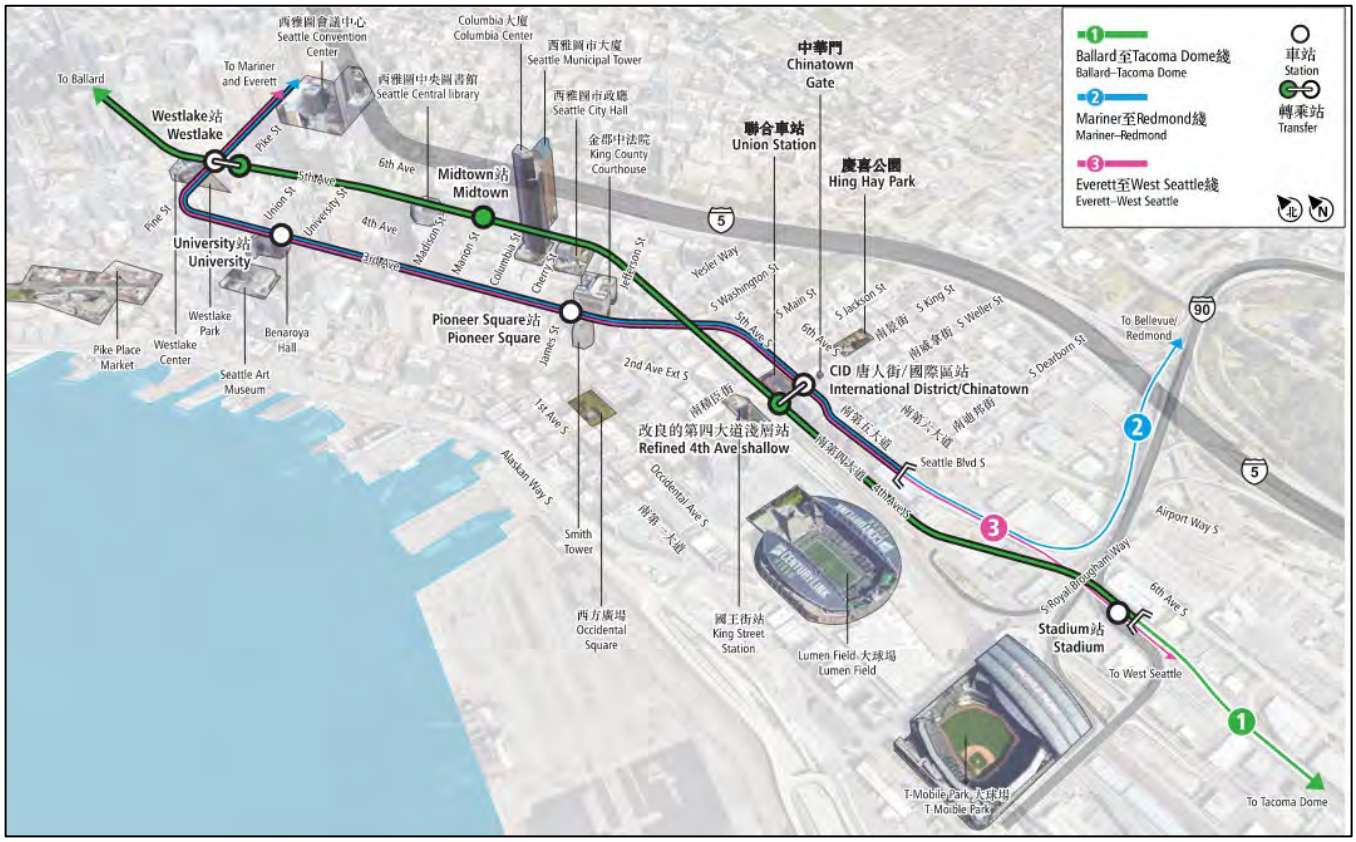


Figure 1 – Refined 4th Ave. Shallow Alignment

Key schedule considerations for the 4th Ave. Shallow Alignment alternative are listed below:

- Twelve years to complete the civil portion of this segment (not including systems, pre-revenue testing, and commissioning).
- Seven to nine years of substantive traffic effects on, and around, 4th Ave. South., 2nd St. Extension, Seattle Blvd., South Jackson St., and Main St.

The latest version of the North and South of CID Alignment is illustrated in Figure 2. The segment begins at the tunnel portal south of Stadium Station and runs north under 6th Ave. South to the South of CID Station located near the intersection of Seattle Blvd. The alignment continues north, tying in at the North of CID Station located east of 4th Ave. in the vicinity of James and Jefferson St.

Key schedule considerations for the North and South of CID Alignment alternative are listed below:

- Seven years to complete the civil portion of this segment (not including systems, pre-revenue testing, and commissioning)
- Four years of full closures on James St. between 3rd and 4th Ave. Six years of full closures on half of Jefferson St. between 4th and 5th Ave. Six years of lane closures along the east curb lane on 4th Ave. between James St. and Terrace St. Five to six years of closure of 6th Ave between S. Royal Brougham Way and Seattle Blvd. (currently closed).

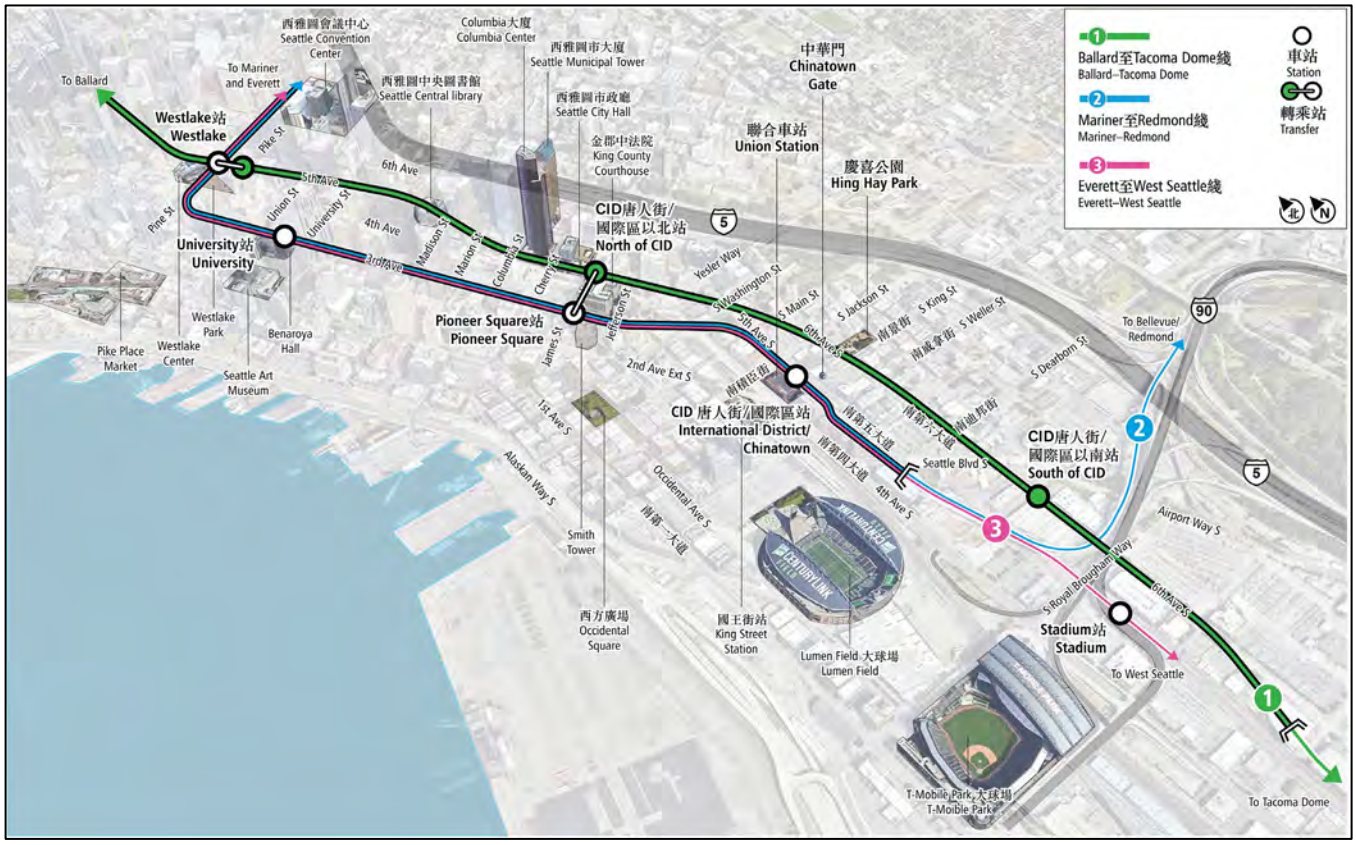


Figure 2 – North and South of CID Alignment (No Midtown Station)

PROJECT DESCRIPTION

A summary presentation was prepared by the Project Team providing the latest overview information on both alignment alternatives. This is included at the end of this section for reference.

INFORMATION PROVIDED TO THE SCHEDULE ANALYSIS TEAM

The following project documents were provided to the workshop team for their use during the study:

- **West Seattle and Ballard Link Extensions Presentation Slides** – Sound Transit
- **CID 4th Shallow Concept Presentation Slides** – Sound Transit
- **Draft EIS Alignments Chinatown-International District Excerpt** – Sound Transit
- **CID Construction Effects Excerpts** – Sound Transit
- **Dave Peters Optimization Strategies Presentation Slides** – Sound Transit
- **CID 4th Shallow Staging Presentation Slides** – Sound Transit
- **North of S Jackson St. Presentation Slides** – Sound Transit
- **4th Shallow Summary Presentation Slides** – Sound Transit
- **North of CID Presentation Slides** – Sound Transit
- **South of CID Presentation Slides** – Sound Transit
- **North + South of CID TBM Utilization Sequencing Presentation Slides** – Sound Transit

West Seattle and Ballard Link Extensions



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Agenda

- Objectives
- CID 4th Shallow Option
  - Concept and Constraints
  - Schedule
- North of CID and South of CID Option
  - Concept and Constraints
  - TBM Utilization Sequencing

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Objectives

- The objective of this workshop is to complete a Schedule Analysis Study for Sound Transit (ST) specifically for the 4th Avenue Shallow Option as well as the North and South of CID Alignment, focusing on the following areas:
  - Validate current assumptions for the 4th Avenue Shallow Option schedule.
  - Validate the overall constructability and activity durations of the North and South of CID Alignment.
  - Identify ways to minimize/eliminate construction impacts to CID and to significantly reduce the duration of construction.

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Board Motion M2023-18

- In the CID Segment: The alignment would include a Station North of CID and a Station South of CID
- The Board directs further study of the CID 4th Avenue Shallower Alternative as part of ongoing environmental review.
- Additionally, the Board directs further study of the following concepts in the Chinatown/International District segment as part of ongoing environmental review:
  - Maximizing connections to all regional/local transit modes comparing the opportunities of the 4th Ave Shallow and 4th Ave Shallower alternatives to the Station North of CID Station and South of CID alternative; and
  - Ways to minimize/eliminate construction impacts to CID (i.e. truck trips, more carbon-friendly excavation and material disposal methods, etc.) and to significantly reduce the duration of construction.

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CID 4th Shallow Concept

Refined 4th Ave Shallow + Midtown



97

Preliminary findings. Analysis is ongoing and is subject to change.

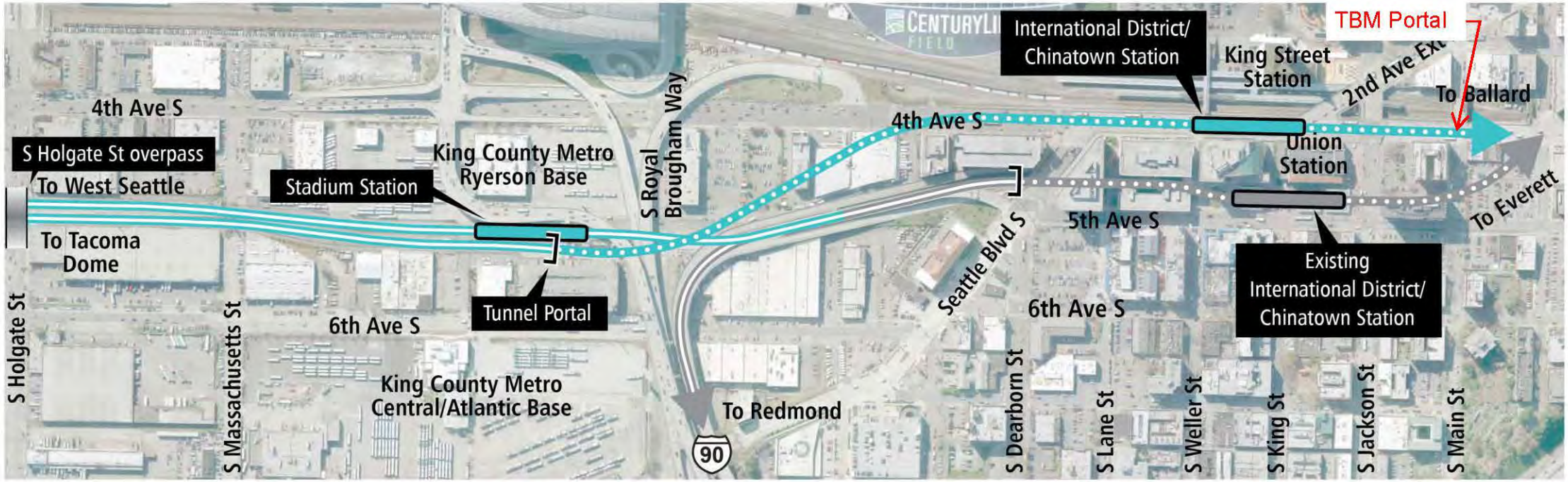
4th Shallow Constraints

- 4th Avenue must remain partially open to traffic between Royal Brougham and S Jackson St
- Coordination with and buildability adjacent to BNSF (secant pile construction); adhere to BNSF operations schedule
- Maintain operations of mainline LRT
  - At cut-over south of station; current assumption is 6-7 weeks of shutdown; bus bridge not viable
  - At crossing of DSTT
- Station platform must remain shallow; Board eliminated deep options
- Minimize/eliminate construction impacts to CID neighborhood
  - Maintain access to ICON Apartments (avoid displacements)
  - Schedule assumed 10 hour days, 6 days/week

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Draft EIS alignments

Chinatown-International District



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Other Build Alternatives

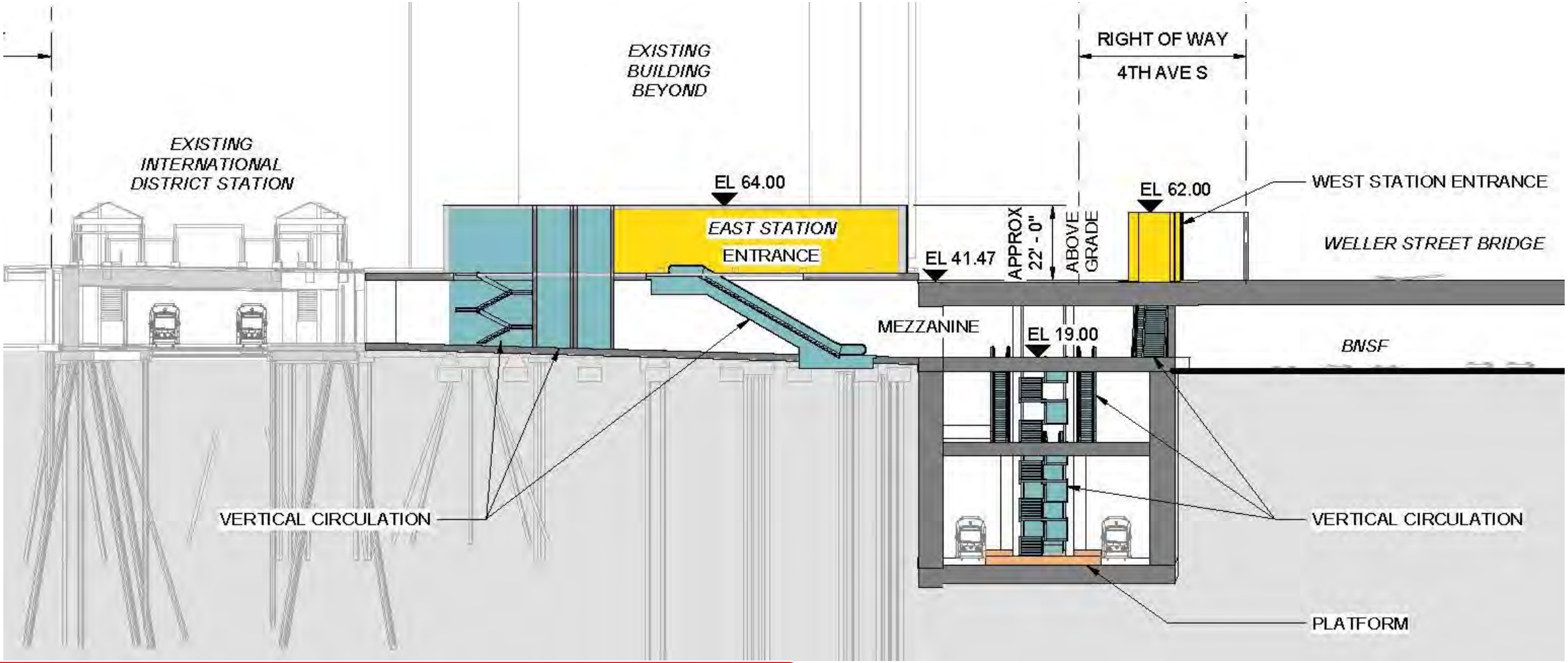


4th Avenue Shallow (CID-1a)

99

Diagrams are not to scale. All measurements are approximate and are for discussion purposes only.

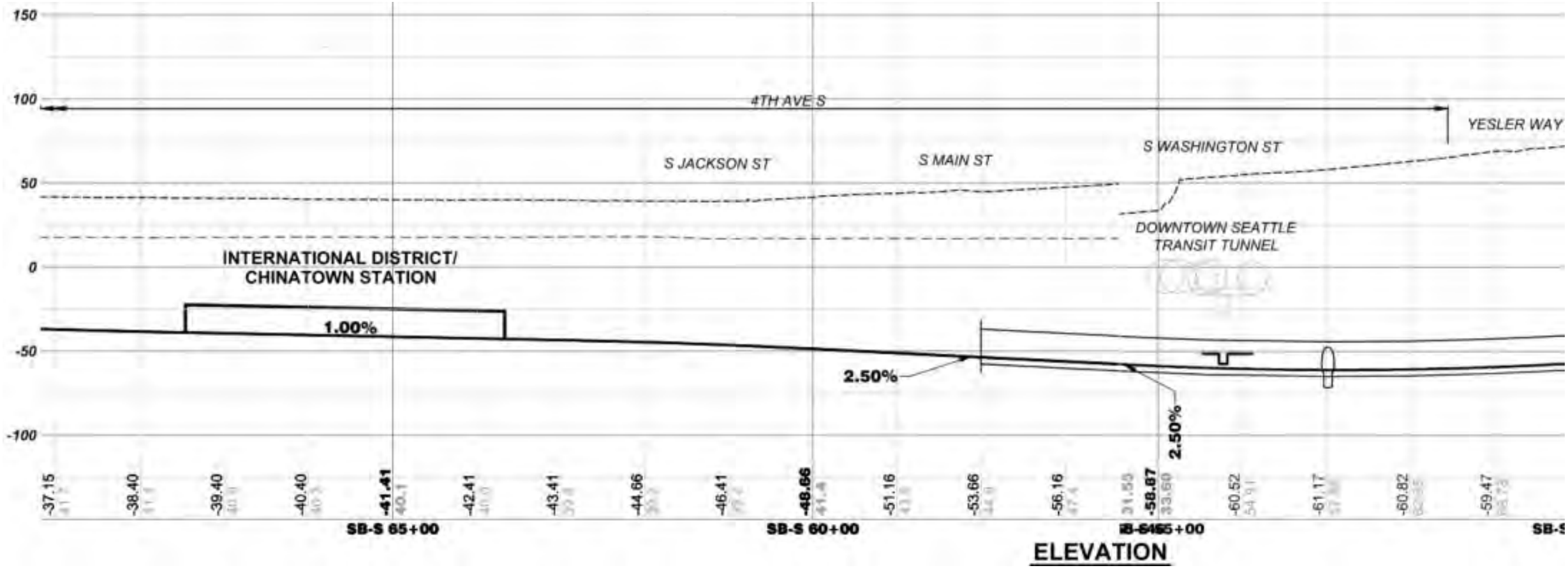
4th Shallow Station Concept



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100

4th Shallow Profile



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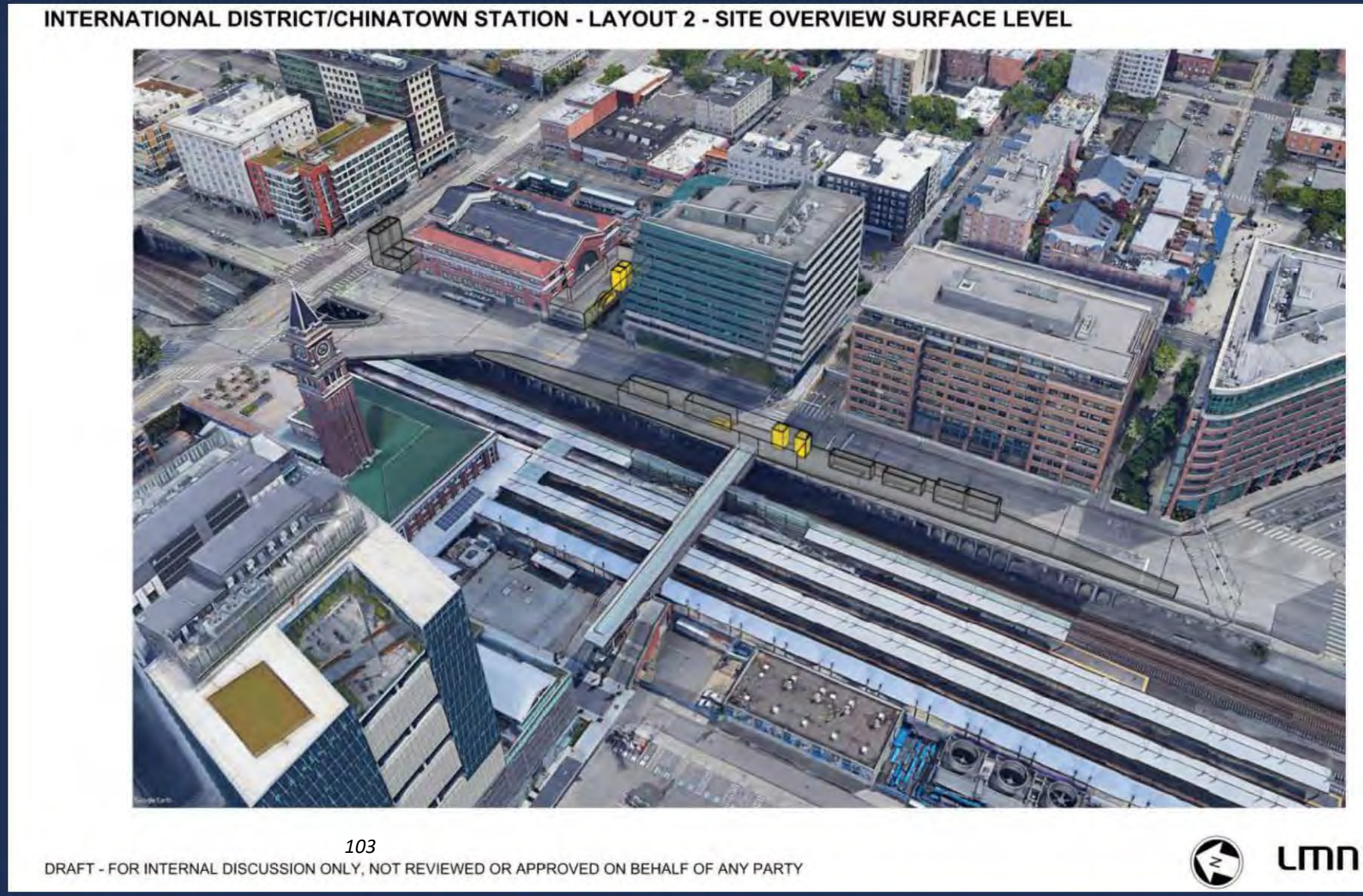
CID Construction Effects

- Transportation Elements
- Utilities
- Structures (Roadway and Adjacent Buildings)
- Construction Staging
- Construction Effects Summary

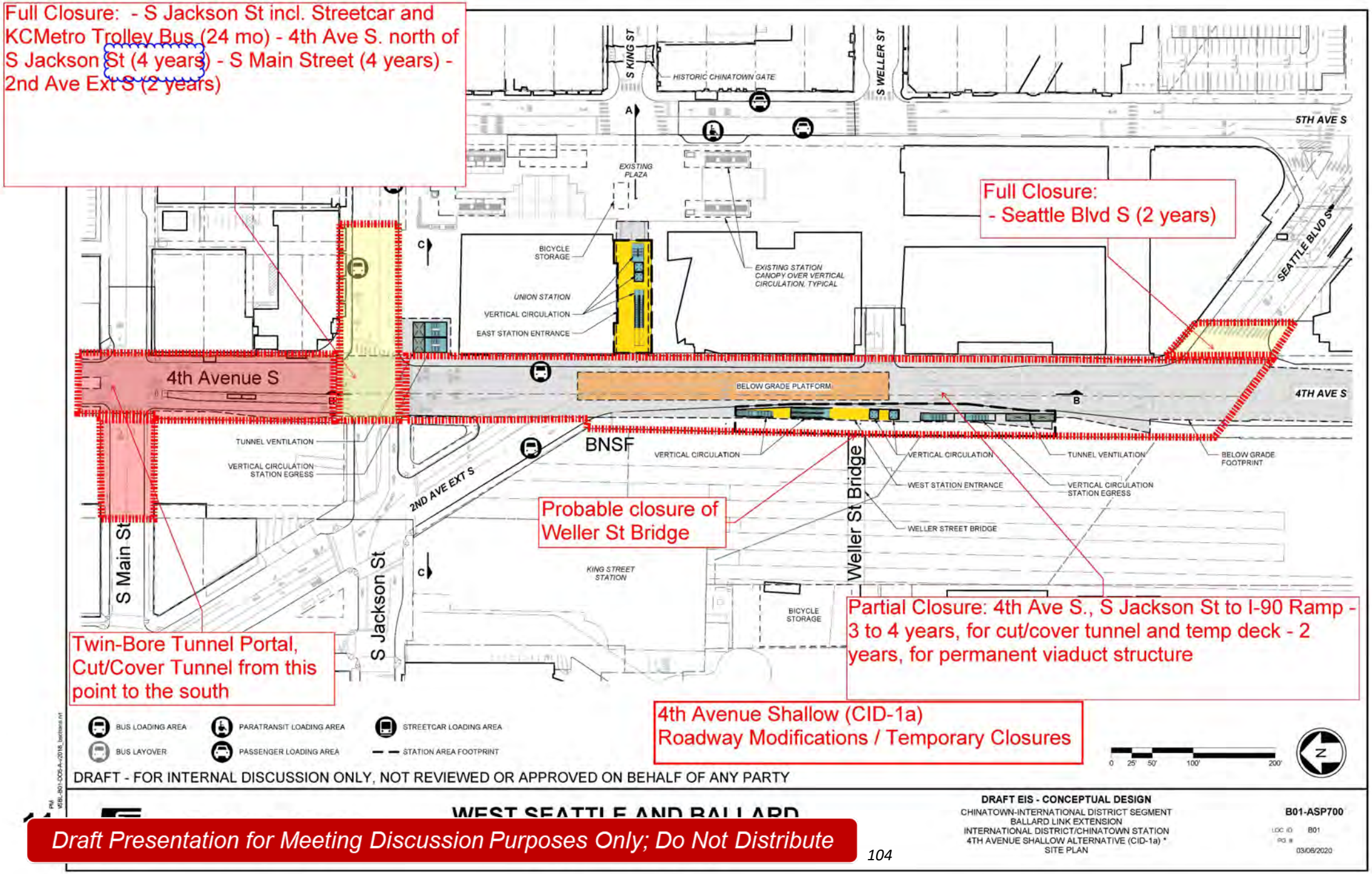
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Transportation Elements – 4th Avenue Alignments

- Roadway Modifications / Closures
- Seattle Streetcar
- KCMetro Trolley Bus
- BNSF and Sounder
- Pedestrian and Bicycle



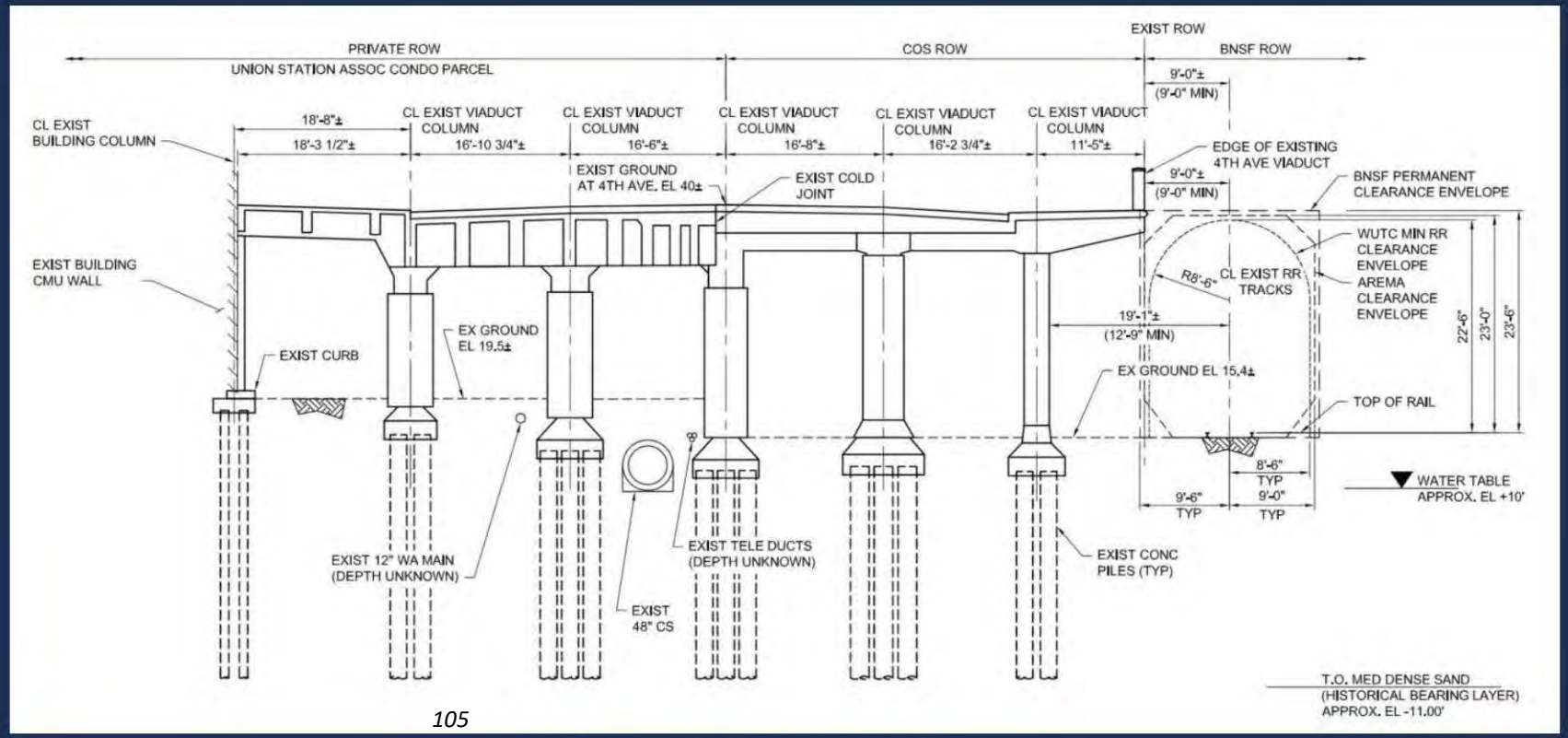
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Utilities – 4th Avenue Alignments

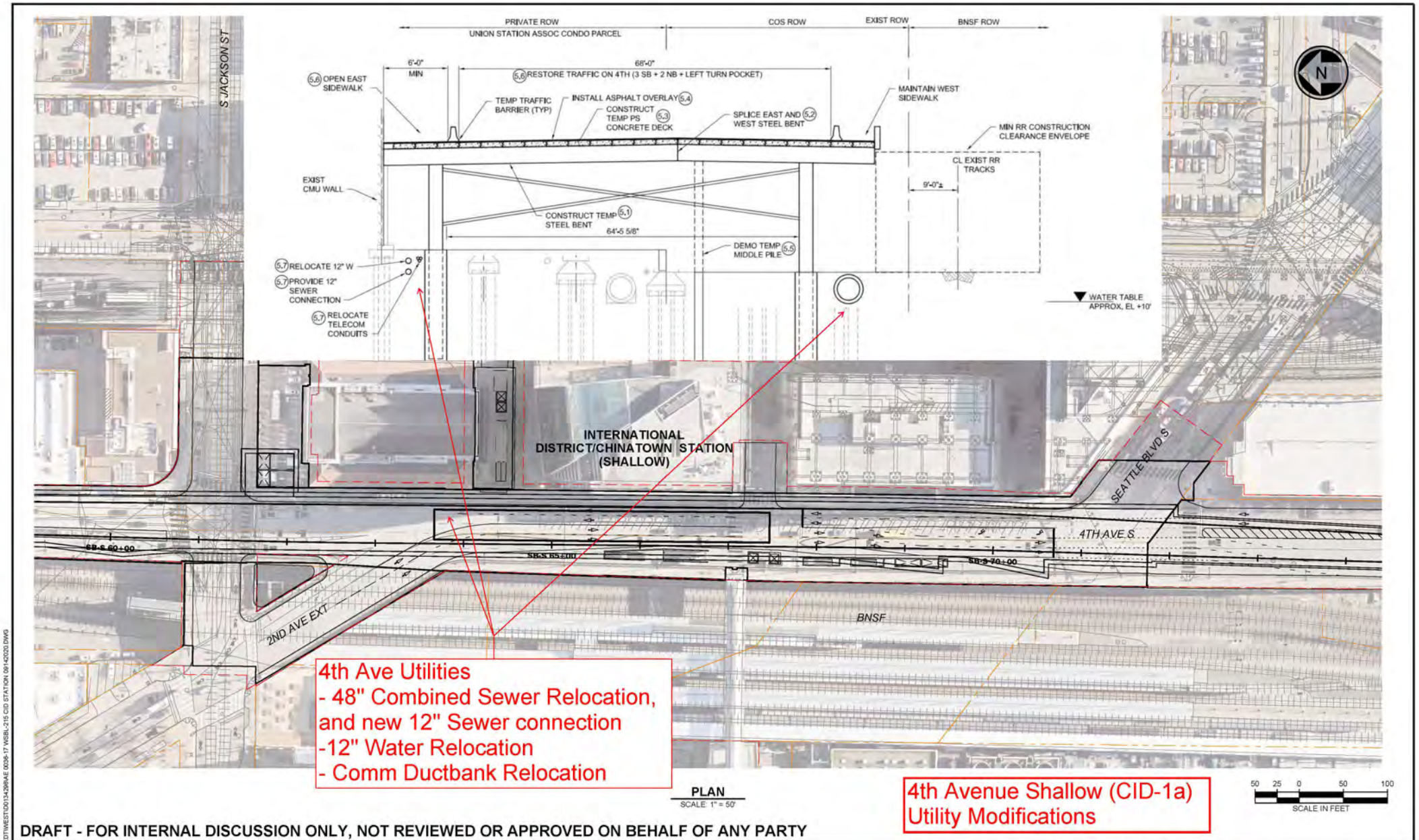
- Existing Street Utilities (Wet/Dry)



105

4th Ave S (Looking South)

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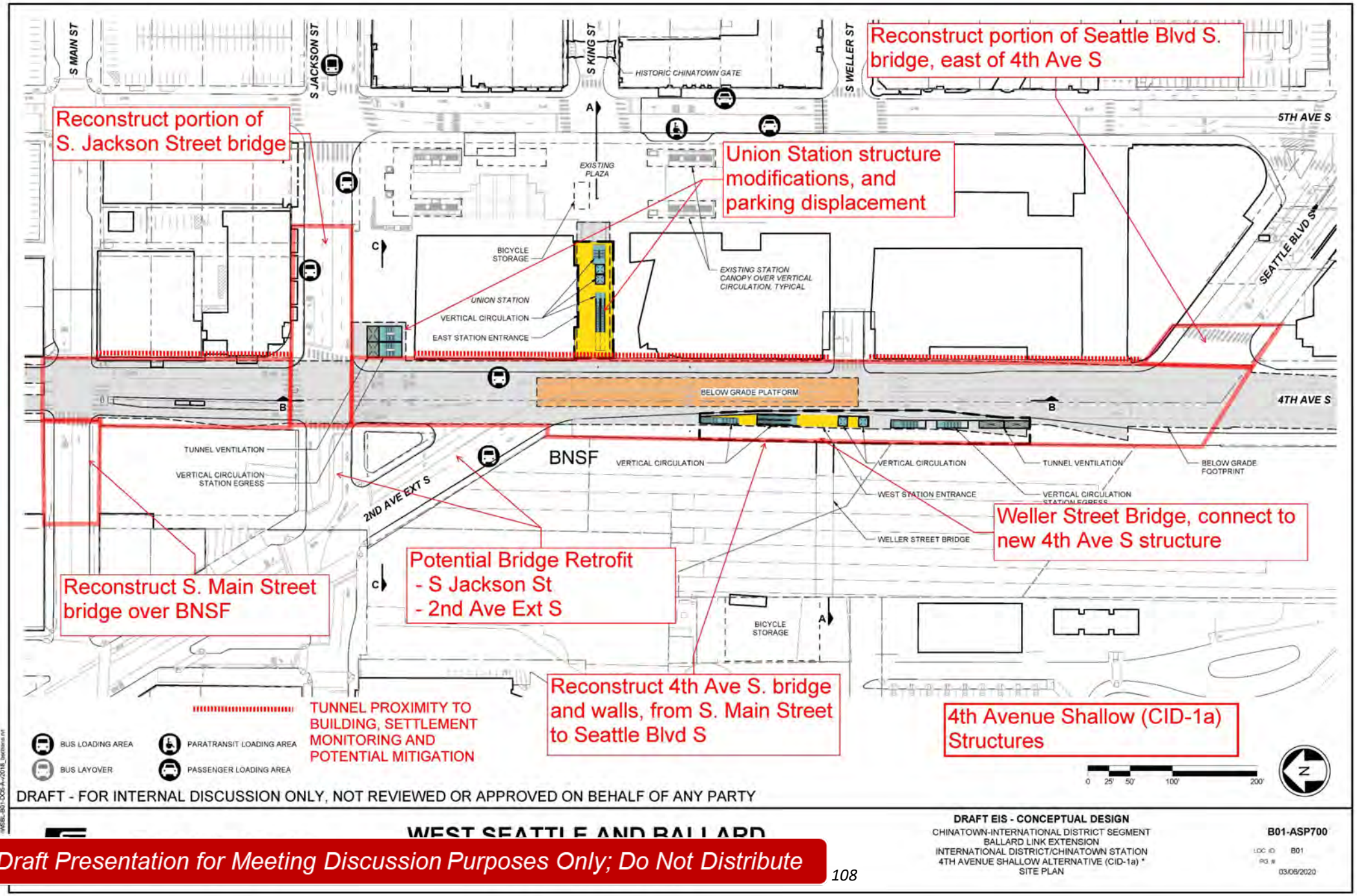
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Structures – 4th Avenue Alignments

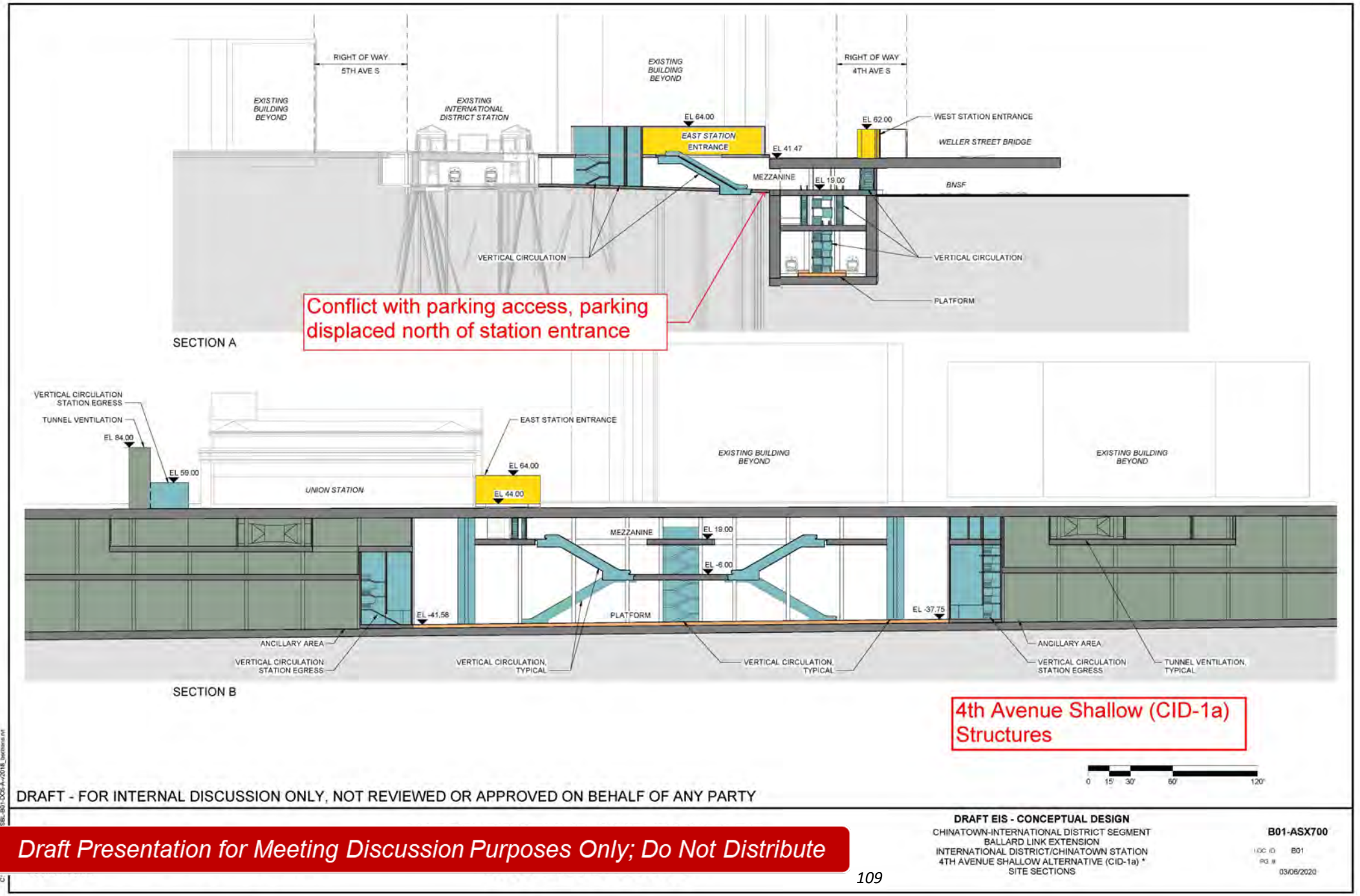
- SDOT Structures
- Weller Street Bridge
- Building Foundations



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Dave Peters Optimization Strategies

List of strategies:

- Case 1 - Top-Down Construction with New Viaduct
- Case 2 - Top-Down Construction with Existing Viaduct
- Case 3 - Retained Cut with Viaduct Canopy
- Case 4 - Station & Track At-Grade
- Case 5 - Optimize Profile

Design team concluded only Case 1 viable (with modifications)

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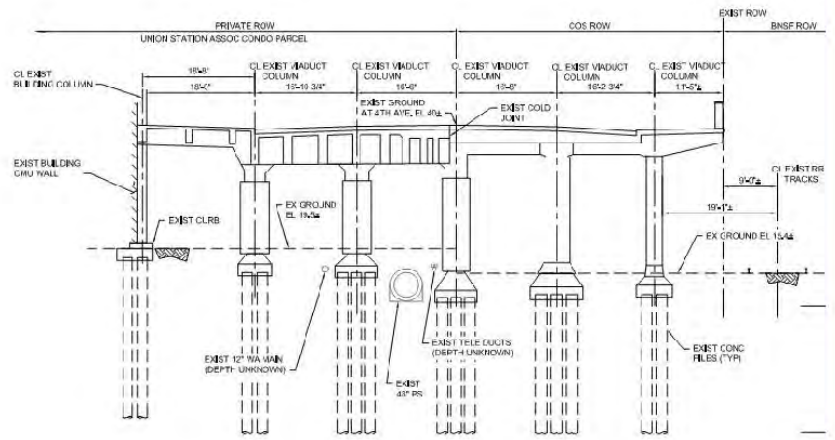
Case 1 Top-Down Construction with New Viaduct Summary

- Technical Evaluation and Benefits:
  - Avoids the intermediate step of the temporary viaduct construction
  - Provides continuous support of excavation
- Challenges:
  - Slurry wall construction adjacent to BNSF mainline tracks
  - Construction of staged deep temporary cross brace support
- Potential refinement:
  - Secant piles with temporary casing
  - Permanent Support using staged deep foundations

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CID 4th Shallow Staging

Summary



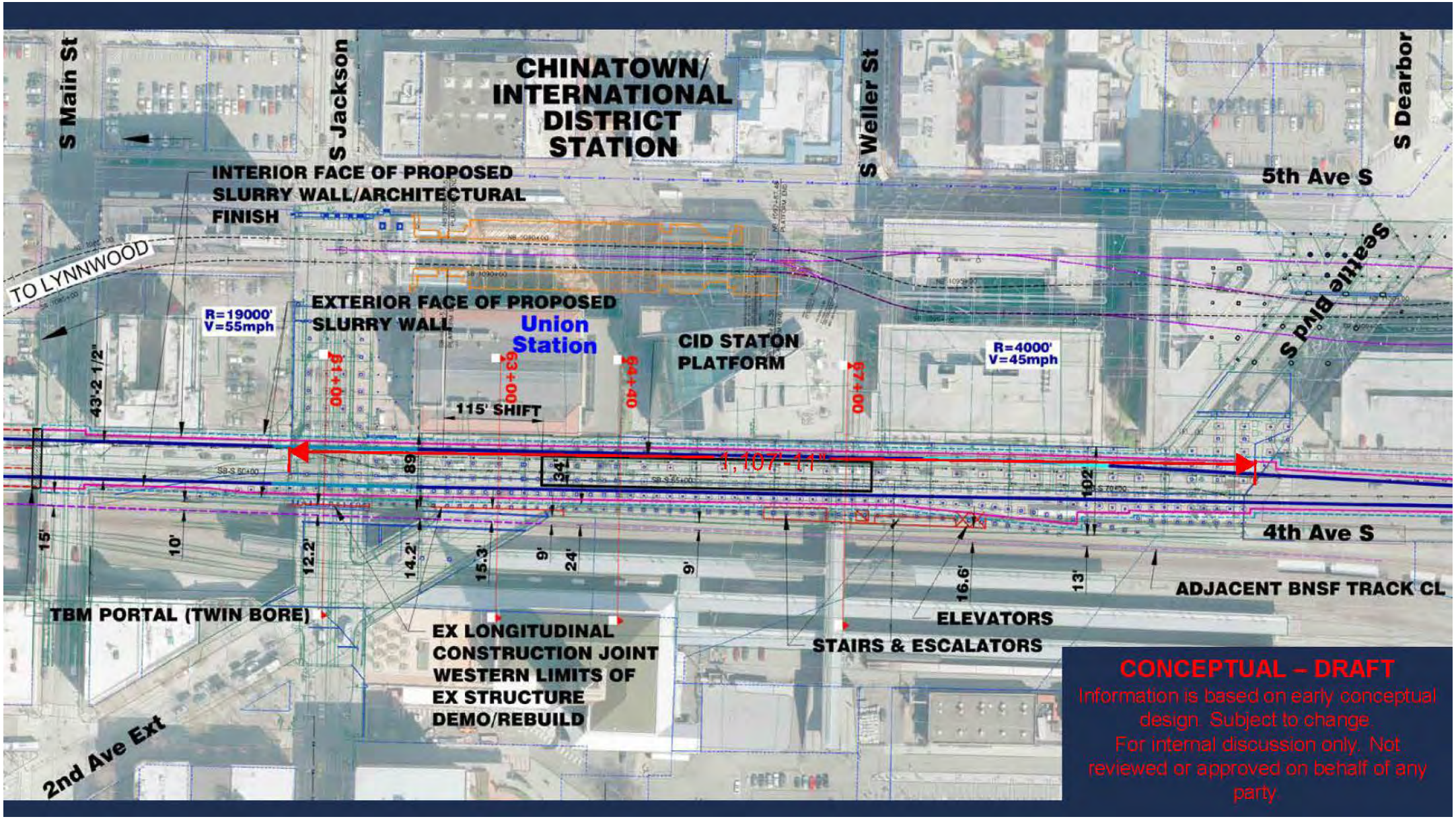
	Concept 1	Concept 2	Concept 3
Key Features	East slurry wall first	West slurry wall first	Existing viaduct retained for 8.5 yrs
Total disruption to 4th Ave (see Slide 9)	4.8 yrs 1 way traffic	4.3 yrs 1 way 18 months closed Main-Jackson (use 2nd Ave)	2.4 yrs 1way 18 months closed Main-Jackson (use 2nd Ave)
Structure Duration	9.5 yrs	9.5 yrs	9.4 yrs
Cost Premium	$0	$4m	$8m

CONCEPTUAL – DRAFT

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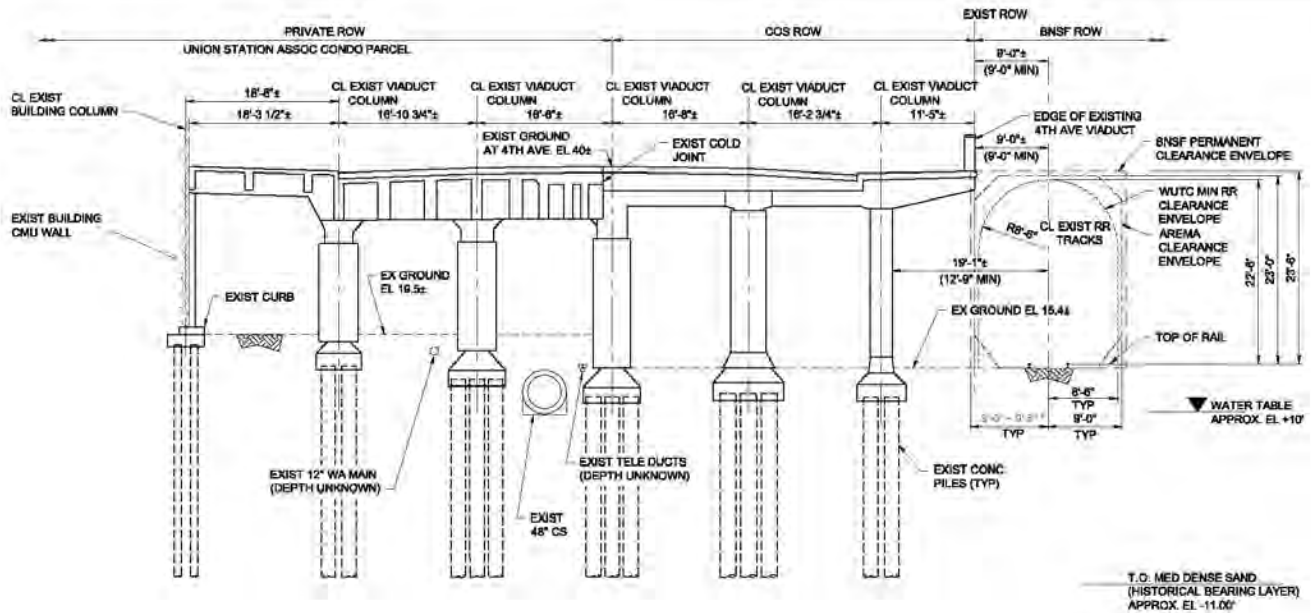
4th Ave Low Center Platform

22



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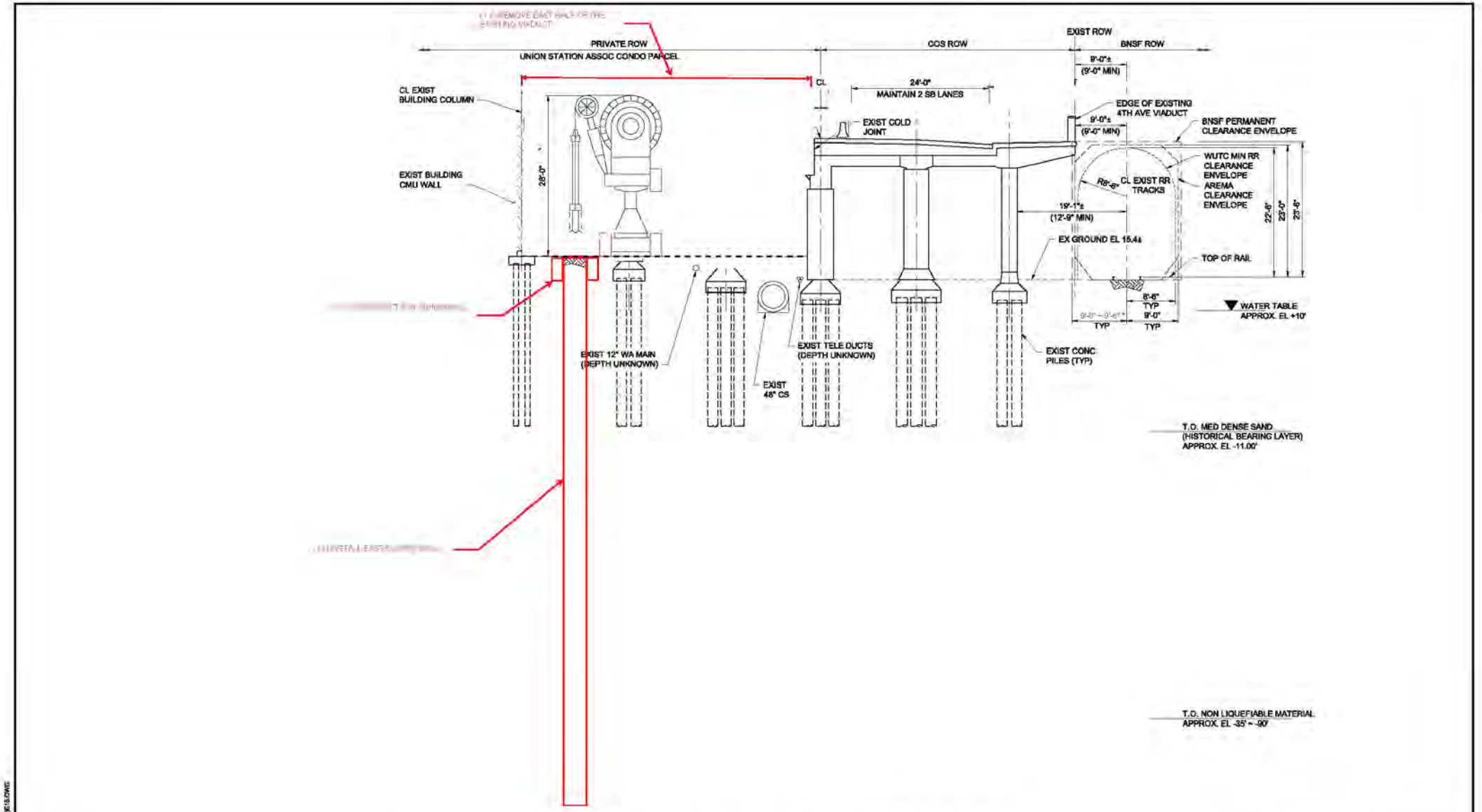
Notes:
* Varies depending on the curvature of the track.

Existing Condition - Typical Section (STA 64+40 / Bent E15)
SCALE: 1/8" = 1'-0"
LOOKING SOUTH

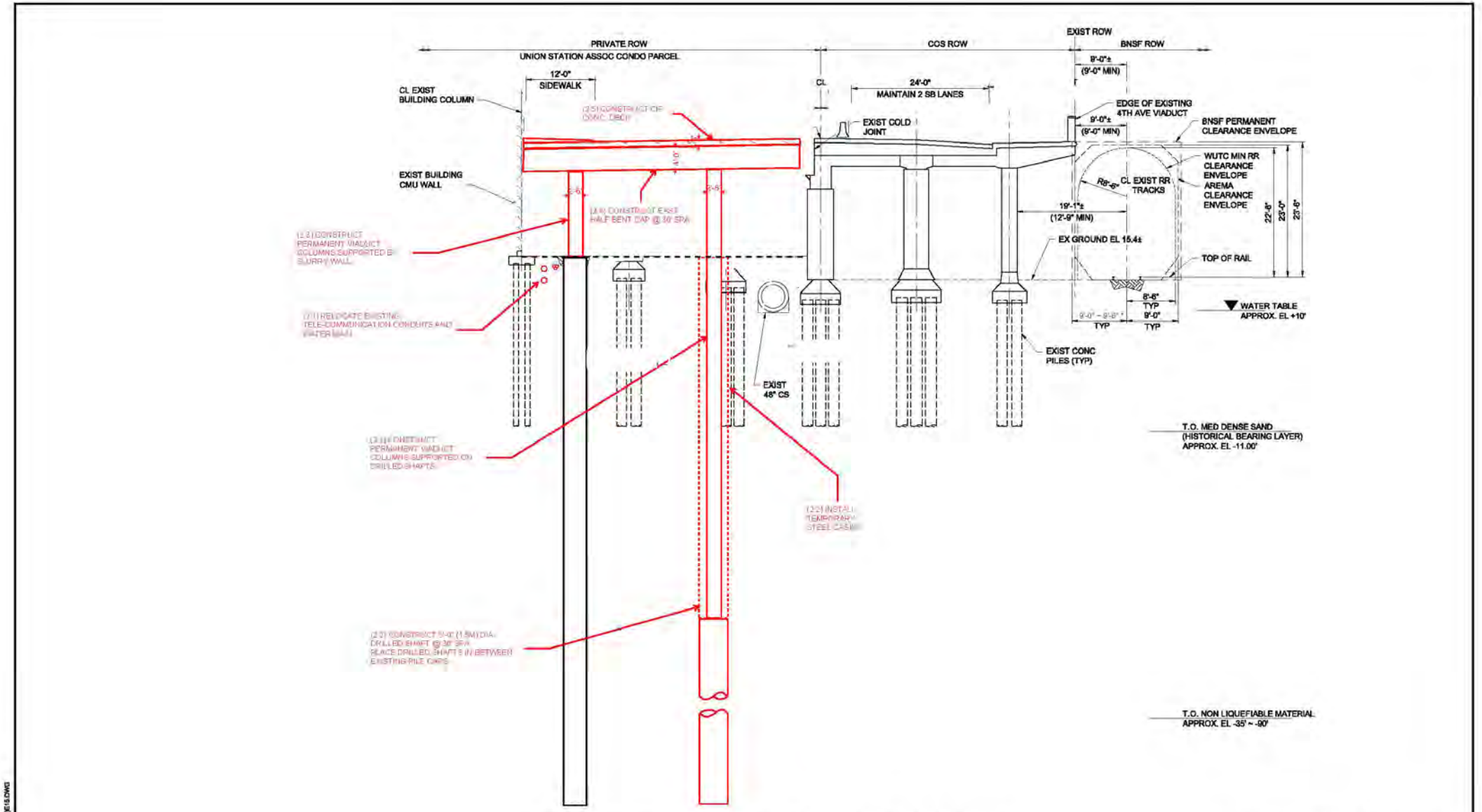
CONCEPTUAL
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DRAWN BY:
SCALE: 1/8" = 1'-0"
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CONTRACT ID: RTA / LR.XXXX.XX
DATE: MM/DD/YY
LINK LIGHT RAIL
WEST SEATTLE TO BALLARD
CID STATION - "4TH SHALLOW" ALTERNATIVE
CONCEPTUAL CONSTRUCTION PHASING
Existing Condition
Typical Section (STA 64+40 / Bent E15)
DRAWING No.: S1
LOCATION No.:
SHEET No.: REV:

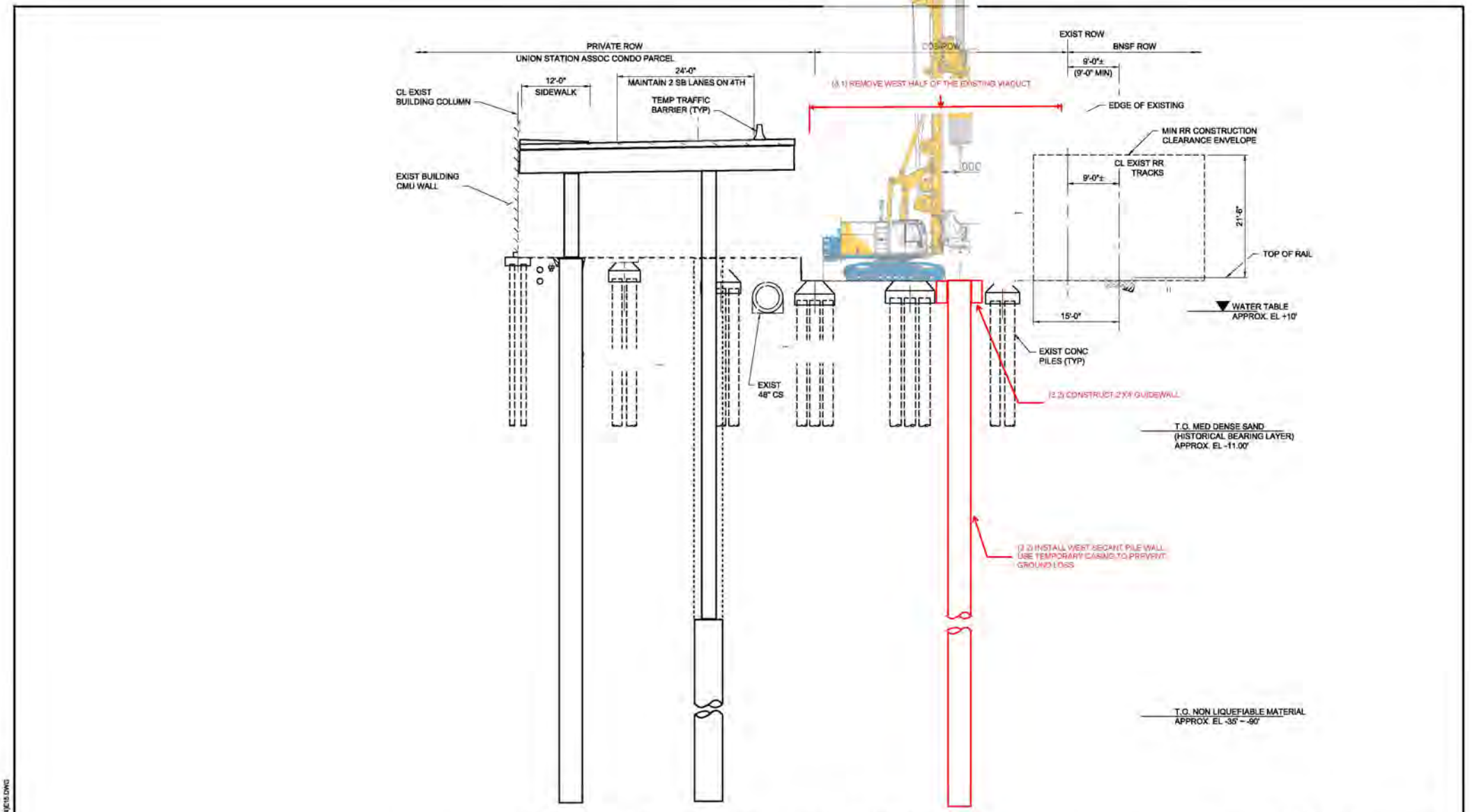
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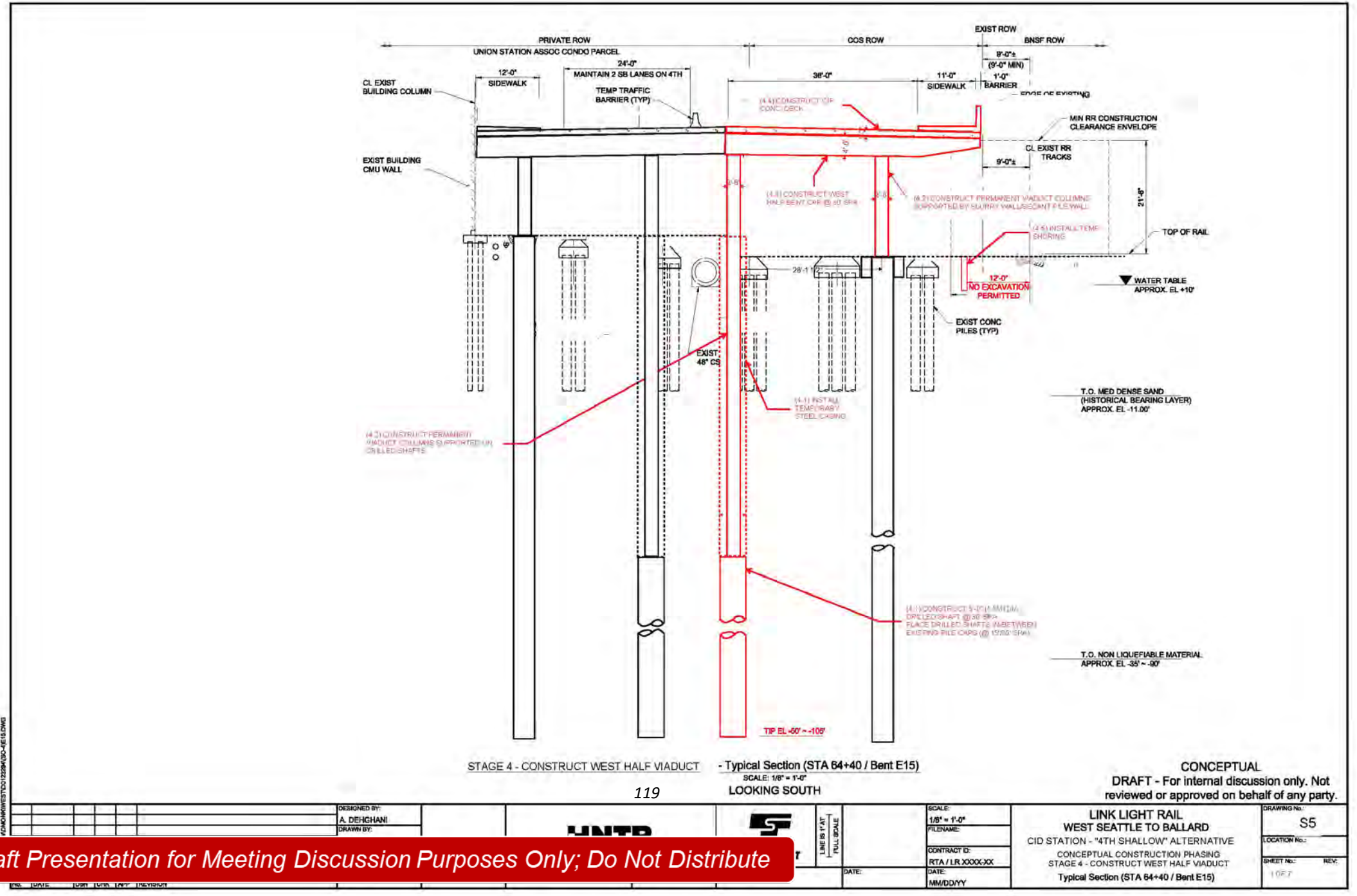
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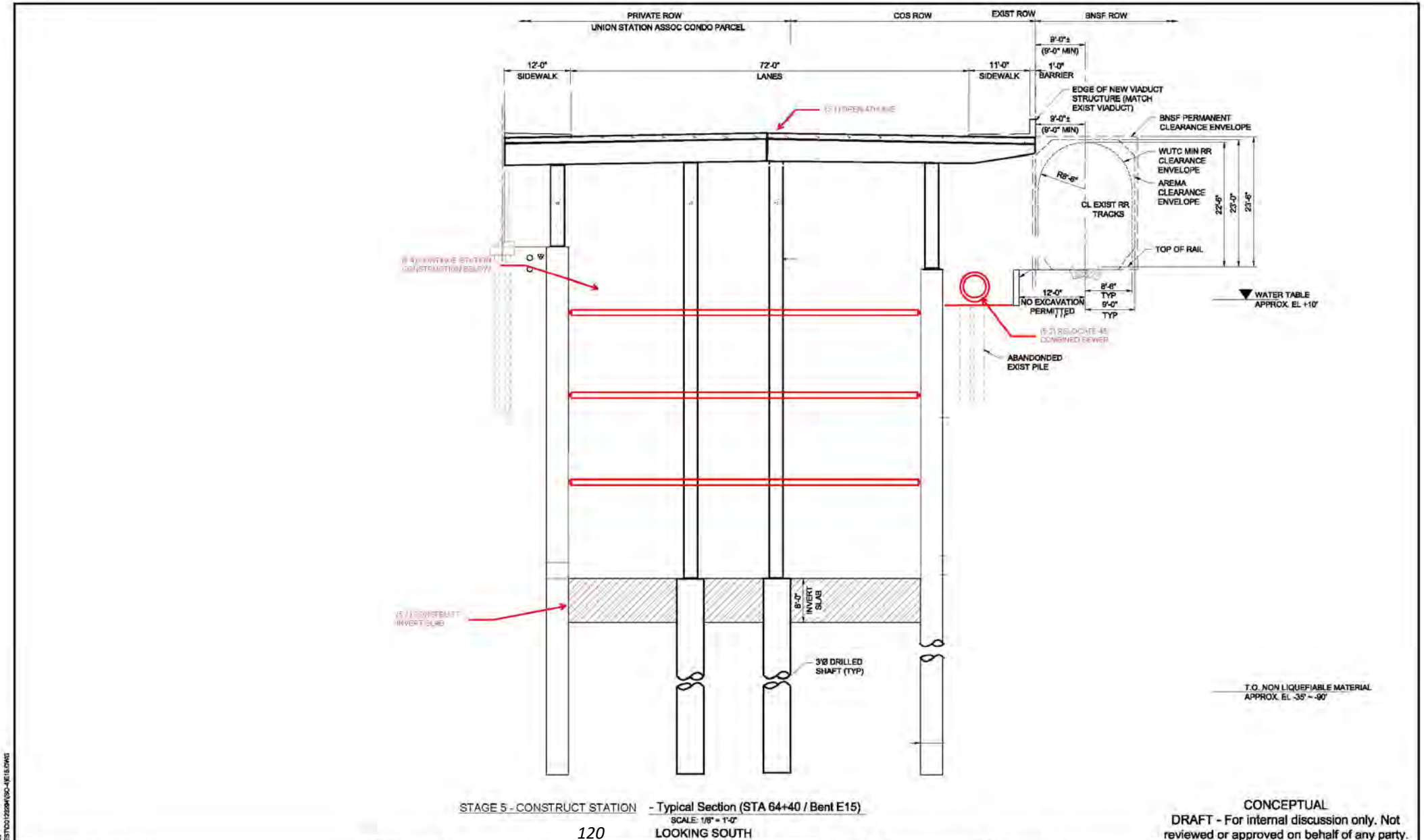
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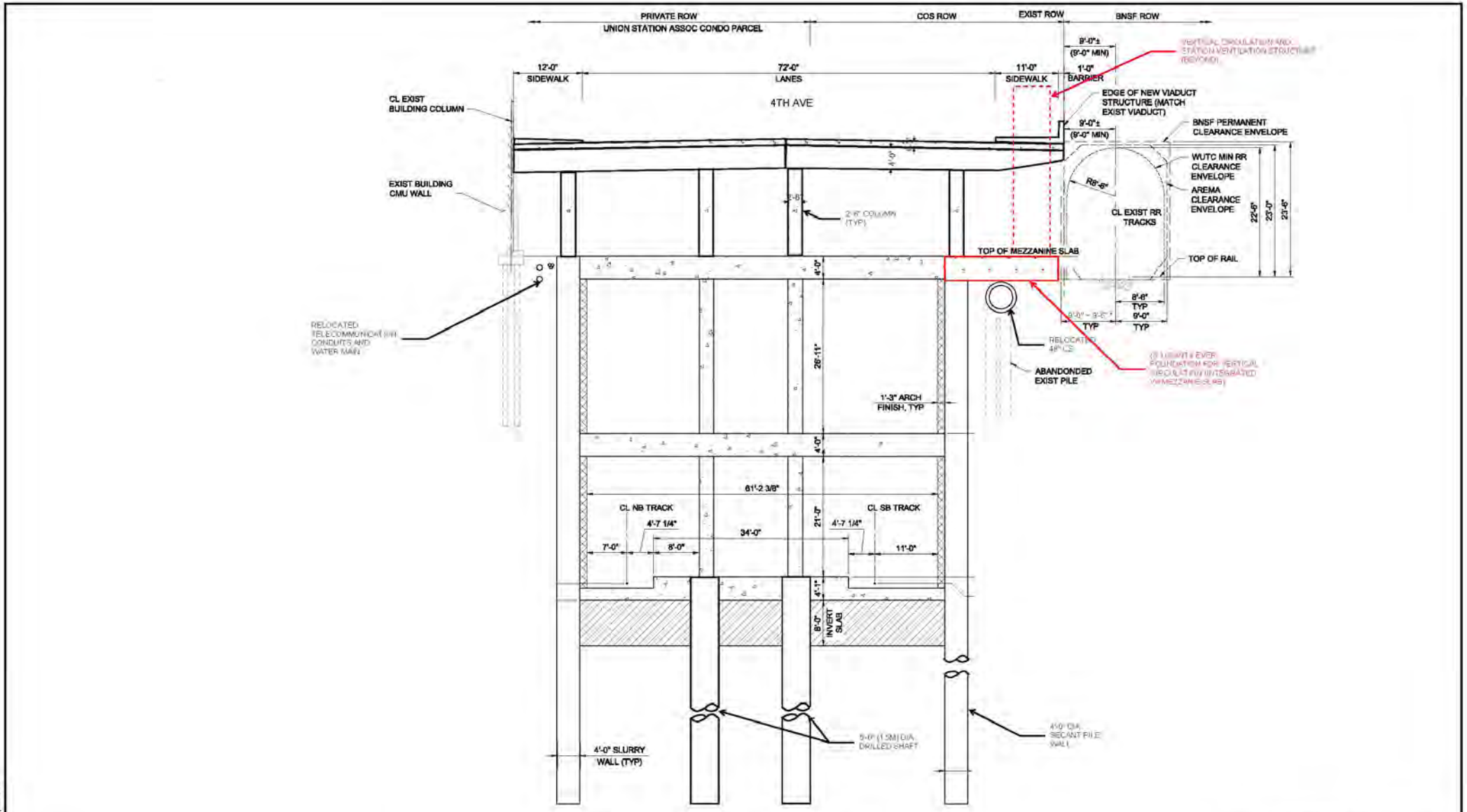
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FINAL CONDITION - Typical Section (STA 64+40 / Bent E15)
SCALE: 1/8" = 1'-0"
LOOKING SOUTH

CONCEPTUAL
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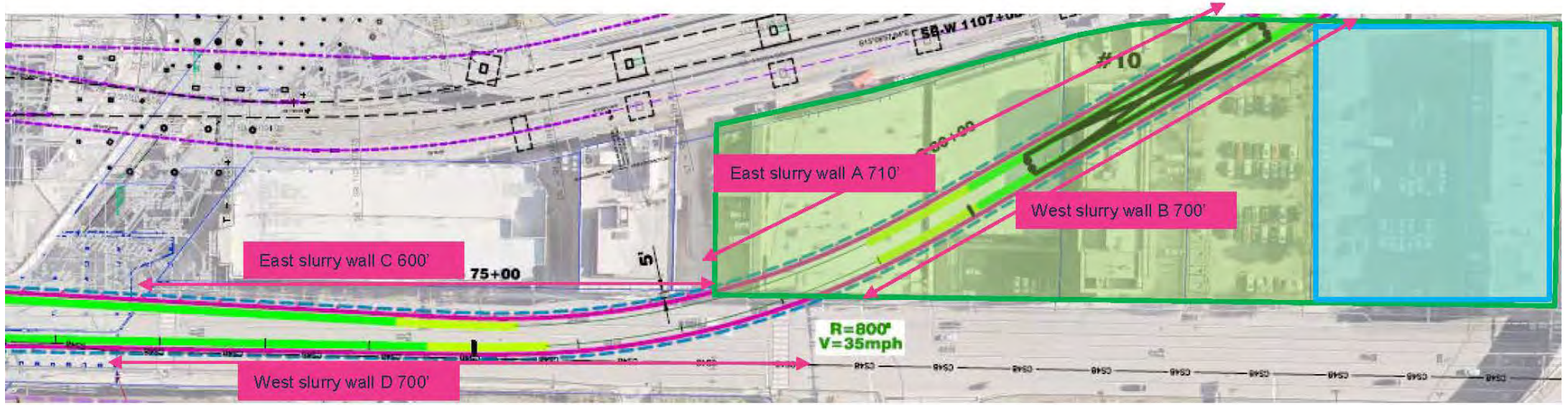
DESIGNED BY: H. GUAN
DRAWN BY:

LINK LIGHT RAIL
WEST SEATTLE TO BALLARD
CID STATION - "4TH SHALLOW" ALTERNATIVE
CONCEPTUAL CONSTRUCTION PHASING
FINAL CONDITION
Typical Section (STA 64+40 / Bent E15)

SCALE: 1/8" = 1'-0"
CONTRACT ID: RTA / LR.XXXX.XX
DATE: MM/DD/YY
DRAWING No.: S7
SHEET No.: 7 OF 7

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Construction Stage 1a: Preliminary



Key: Working space Slurry processing

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4th Ave Low Center Platform

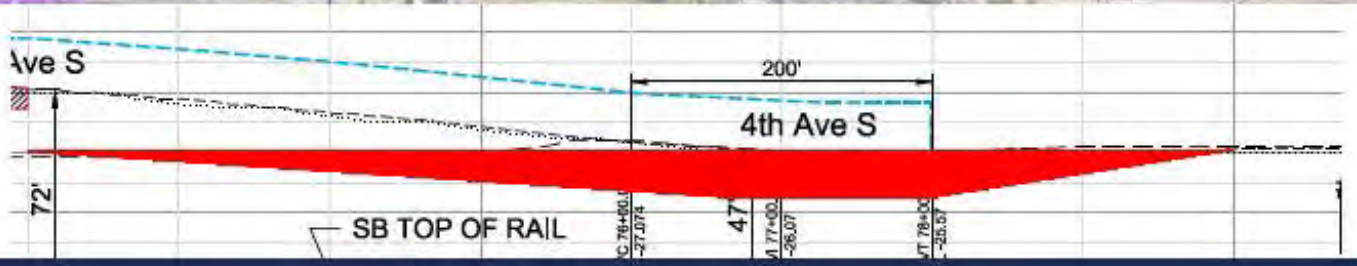
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Construction Stage 1b: Preliminary





Install temp deck in 2 phases, from I90 off-ramp to Seattle Blvd
Excavate under deck to provide access from staging area to underneath viaduct

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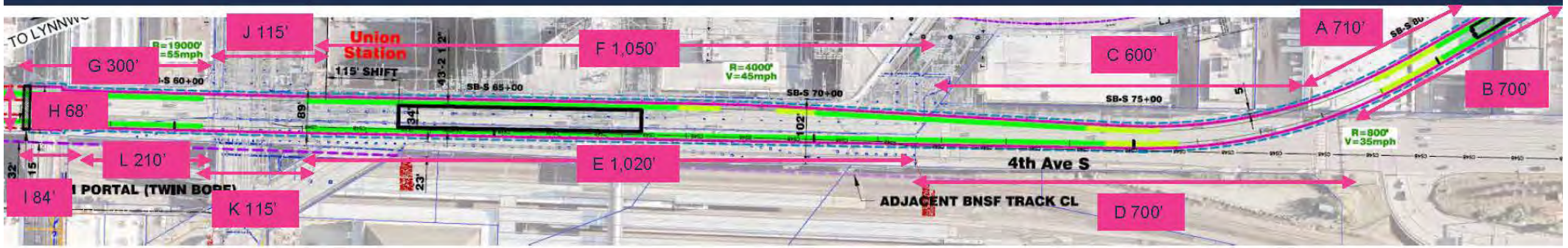
4th Ave Low Center Platform

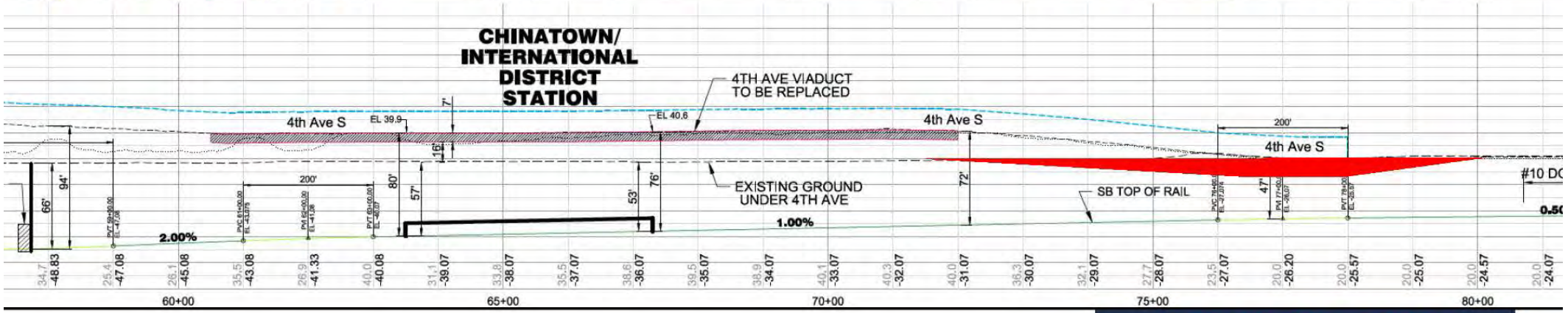
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Construction Stage 1-5 Slurry Walls





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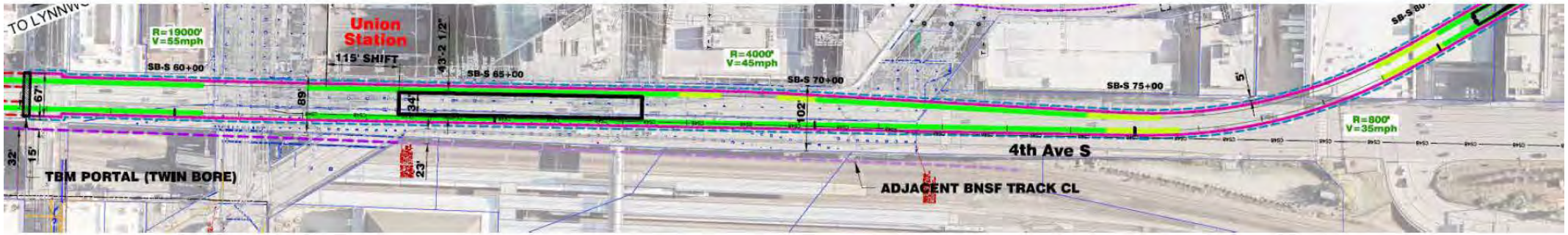
4th Ave Low Center Platform

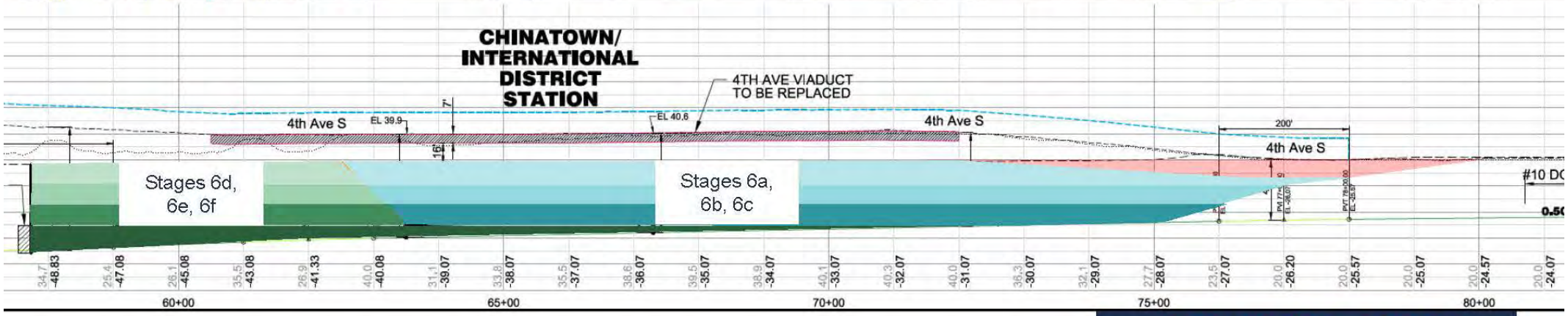
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Construction Stage 6 Excavation





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4th Ave Low Center Platform

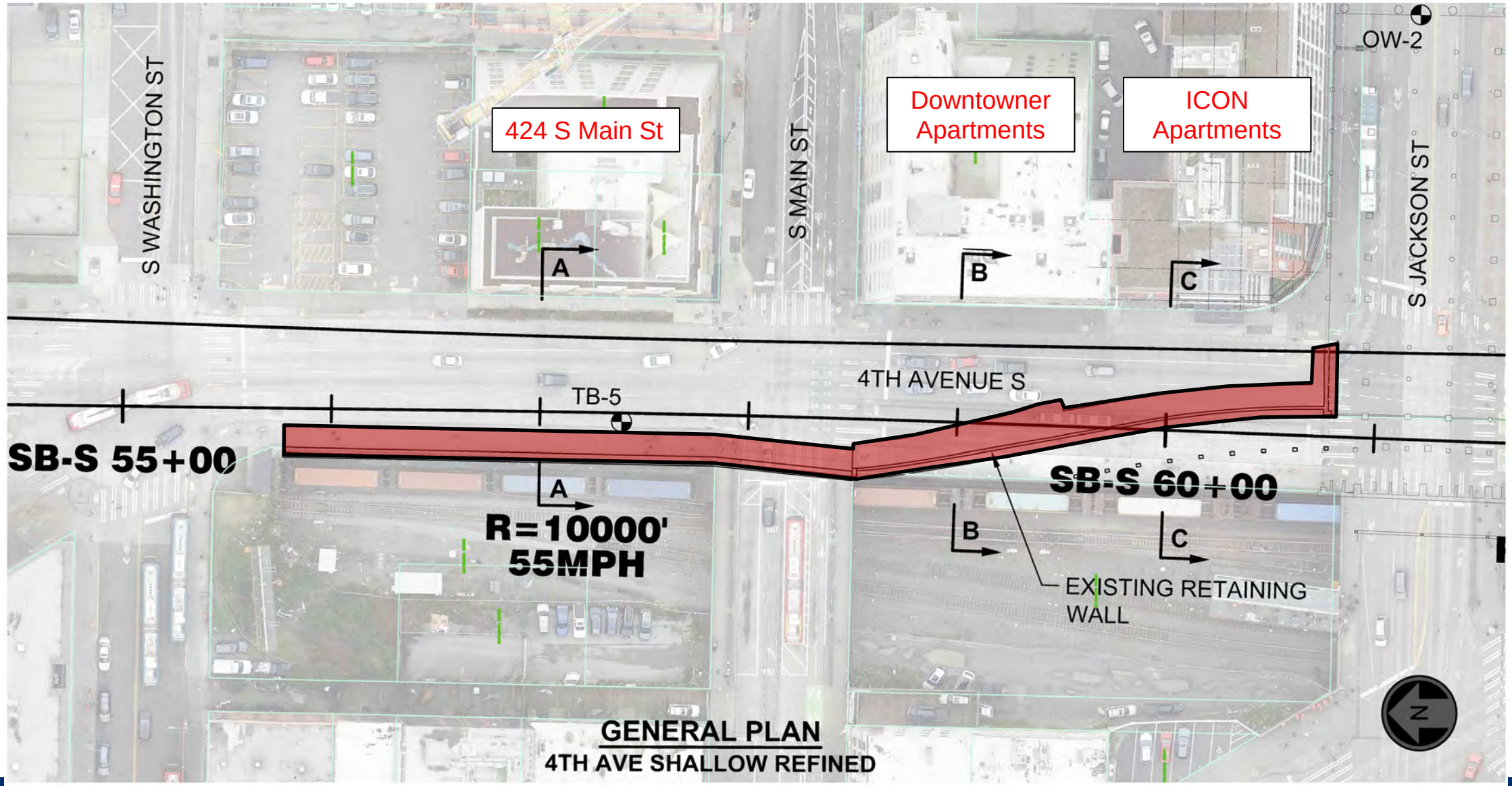
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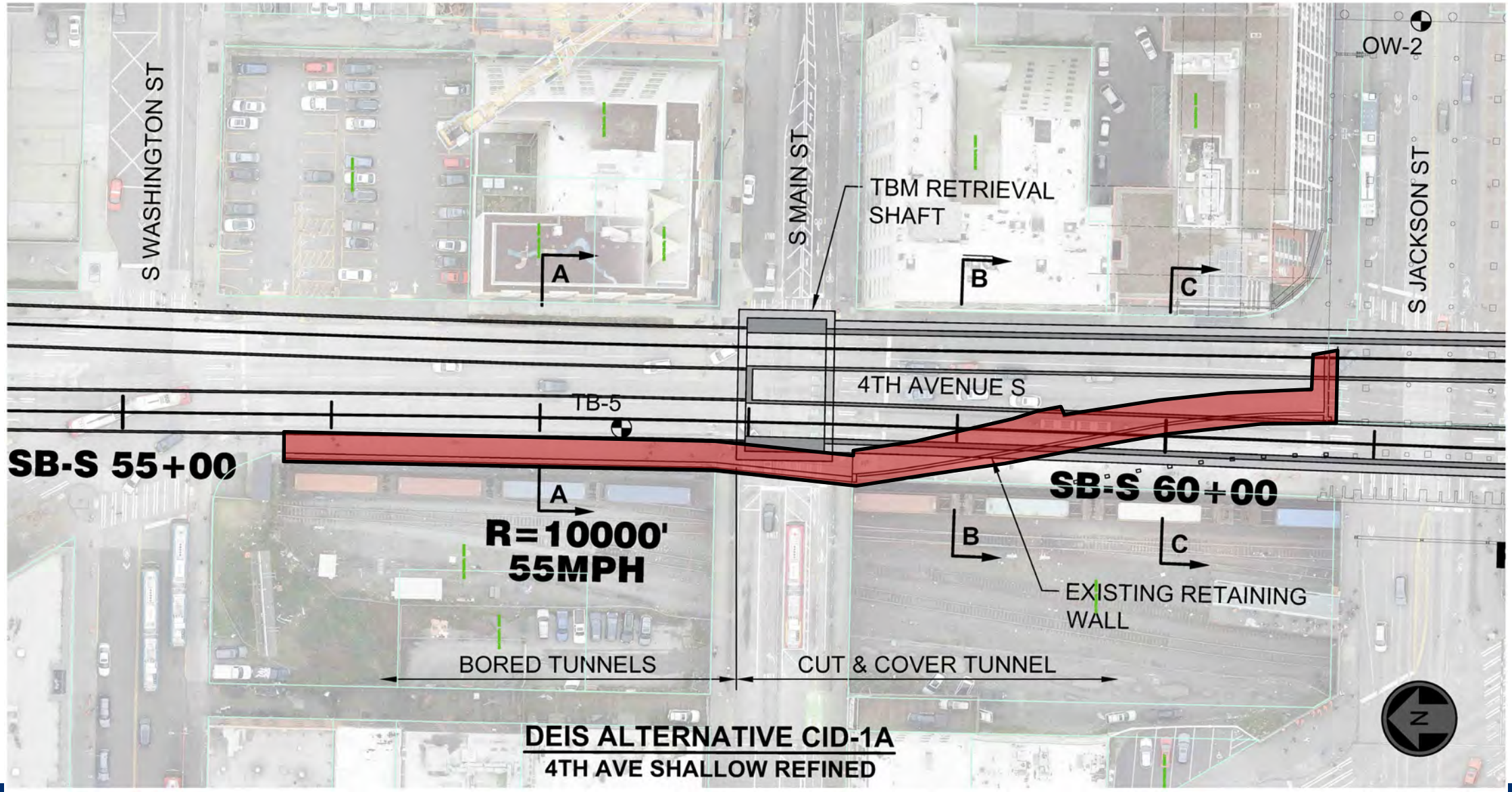
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SOUNDTRANSIT

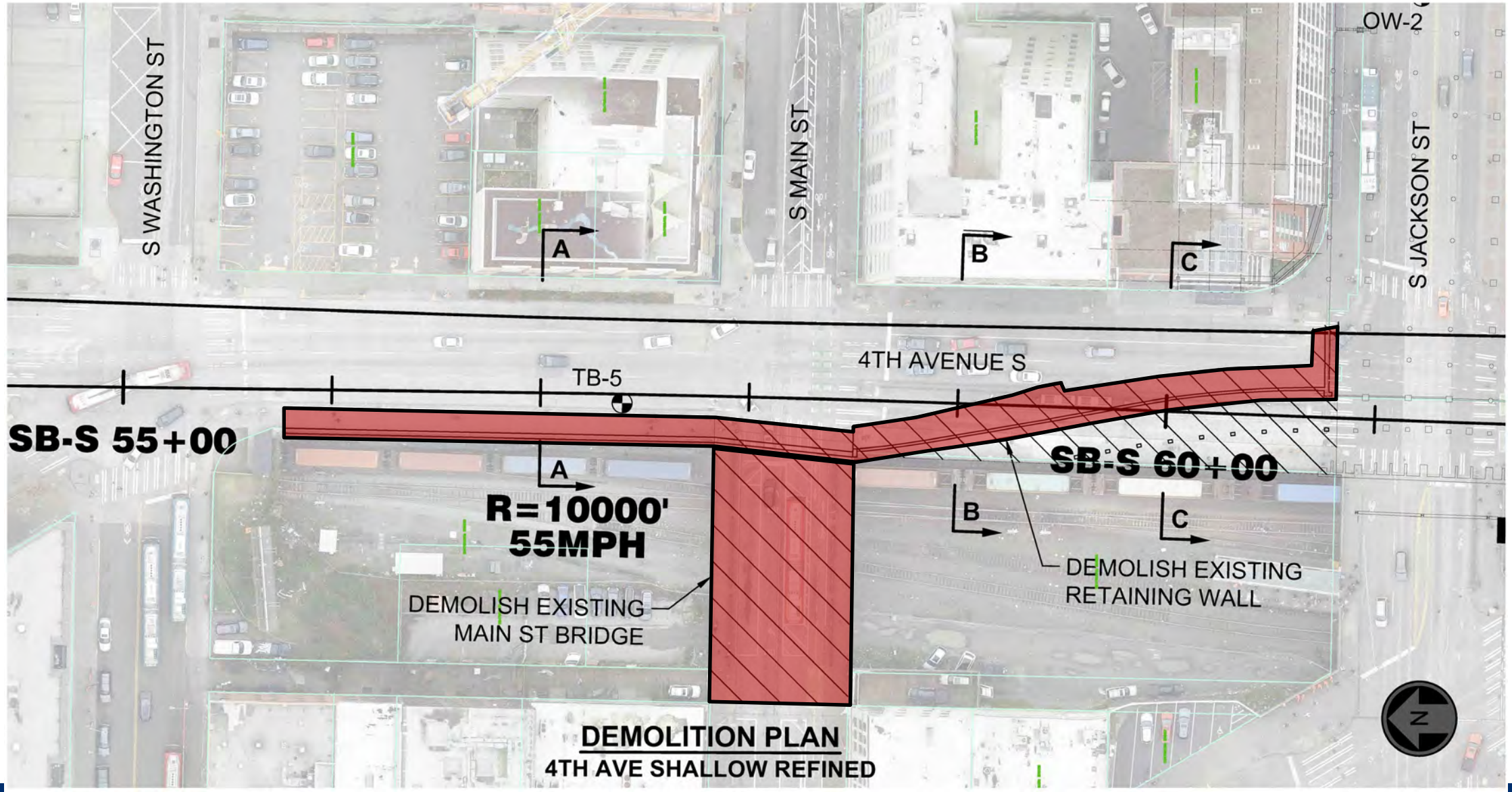
North of S Jackson St



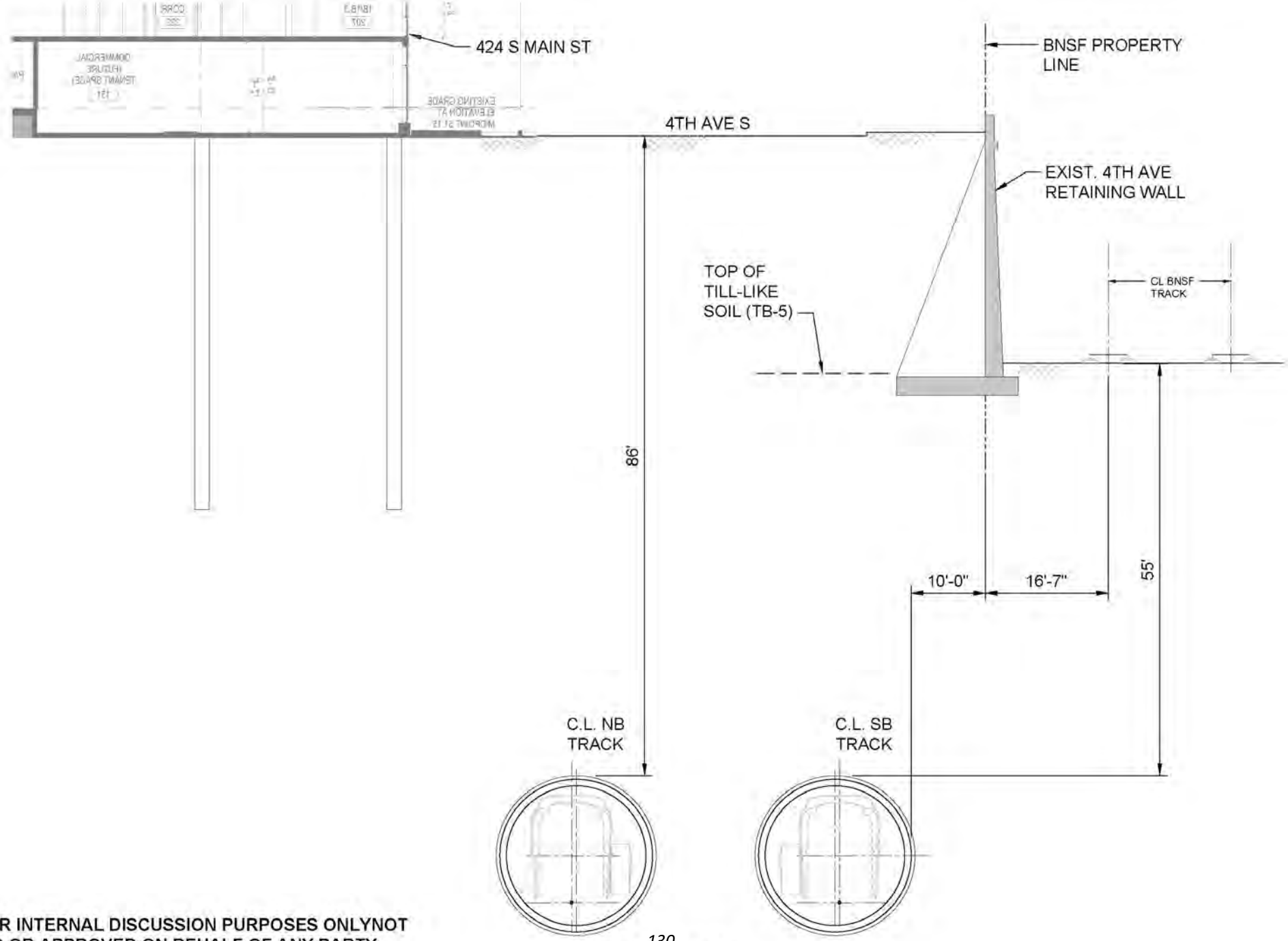
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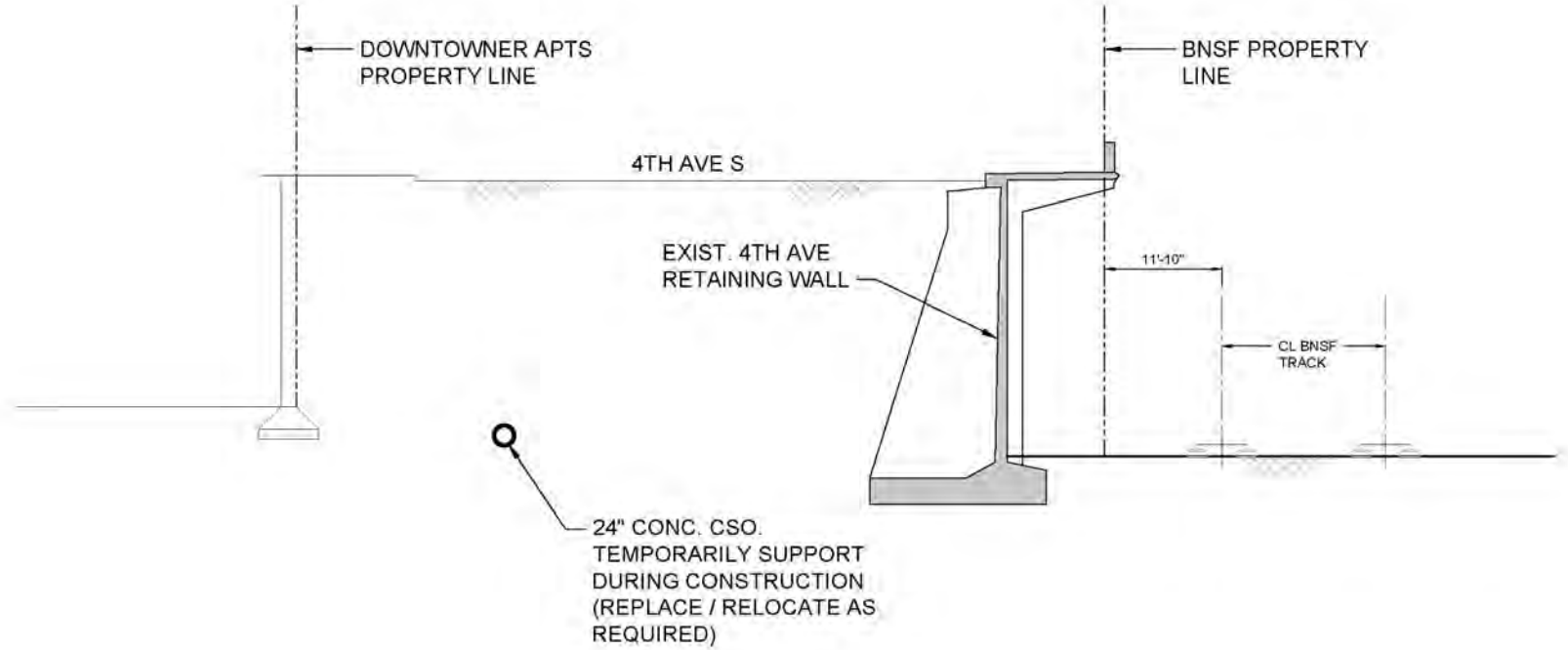


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SECTION A

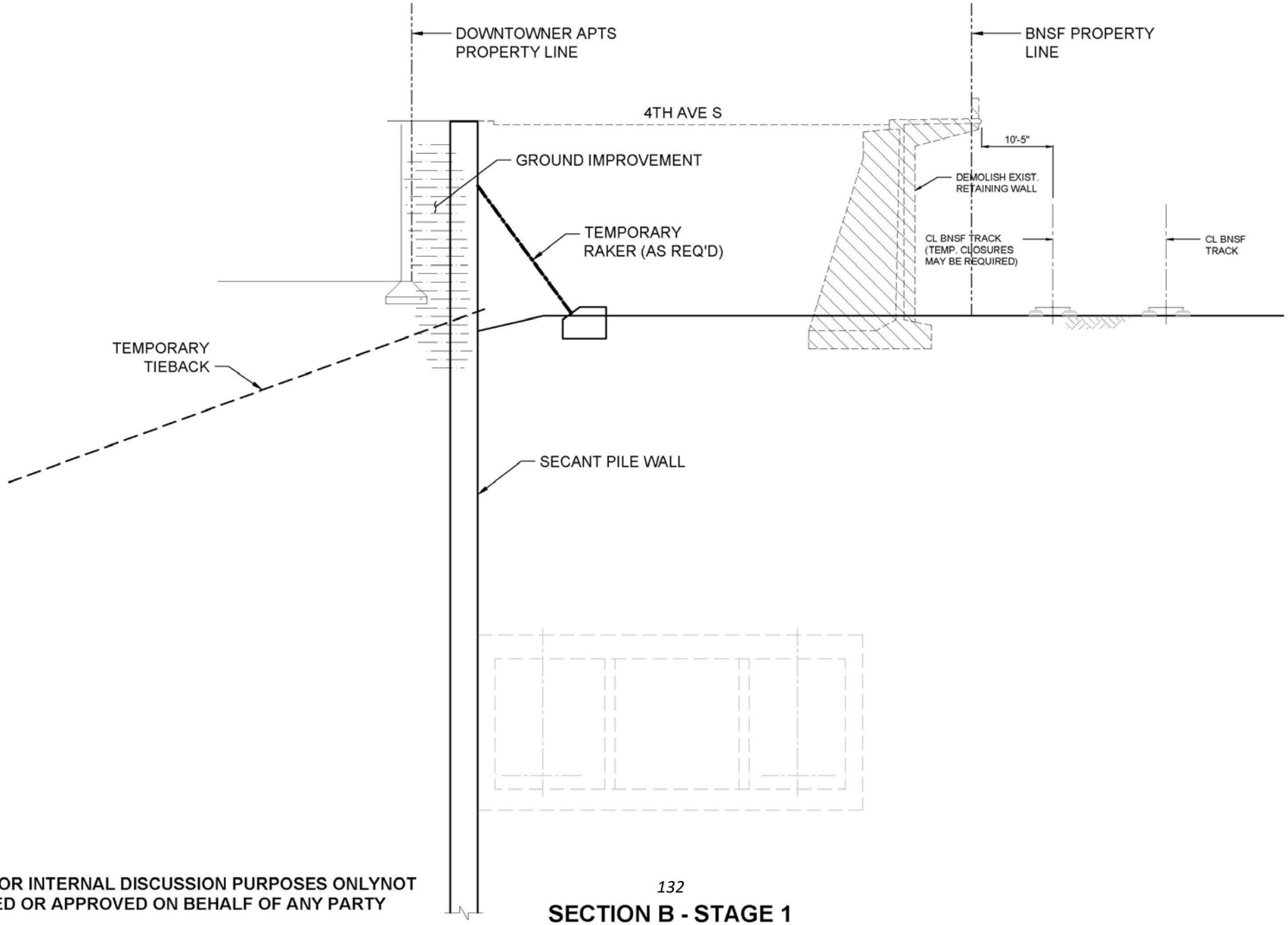
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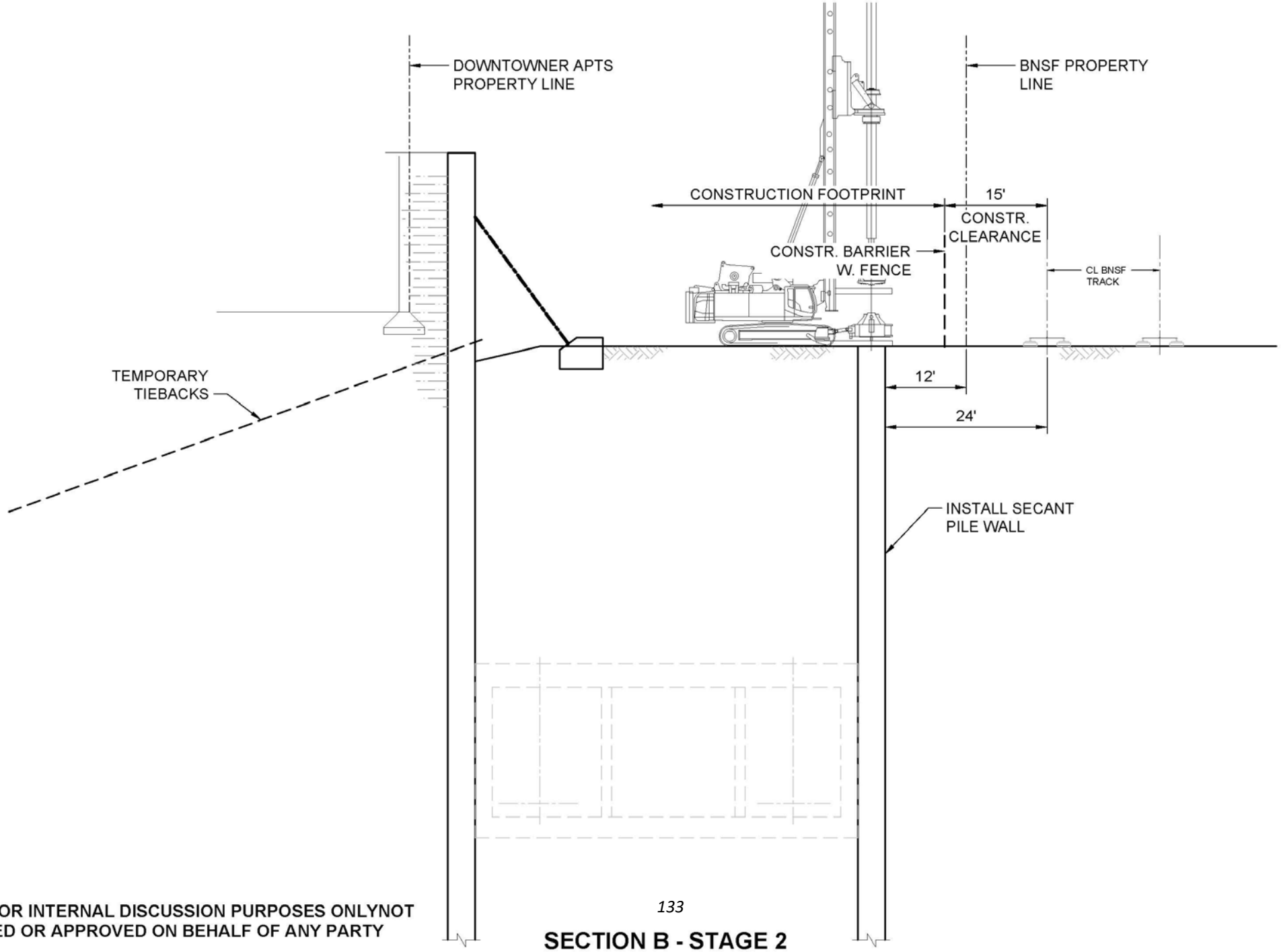
SECTION B - EXISTING CONDITION



132

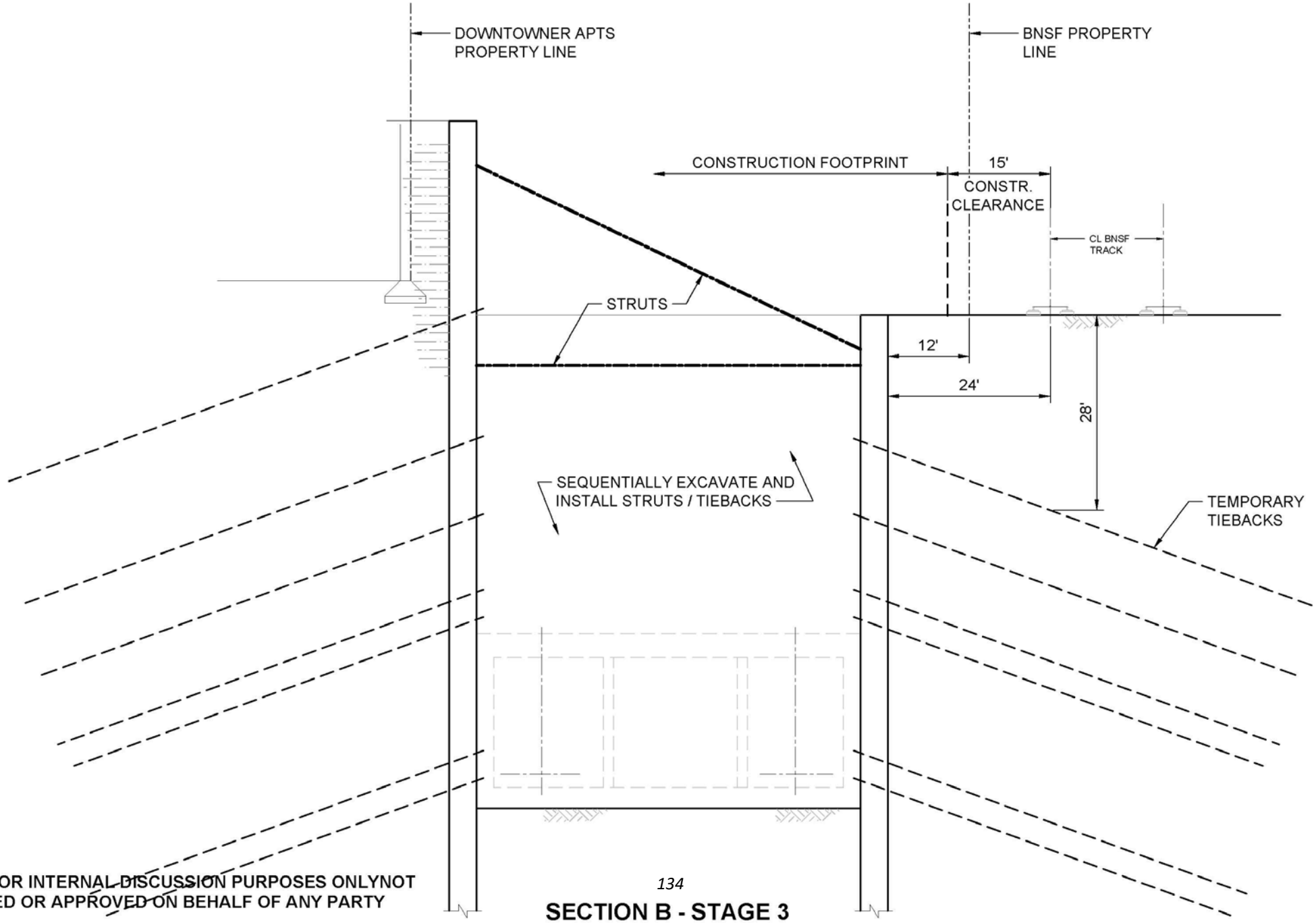
SECTION B - STAGE 1

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SECTION B - STAGE 2

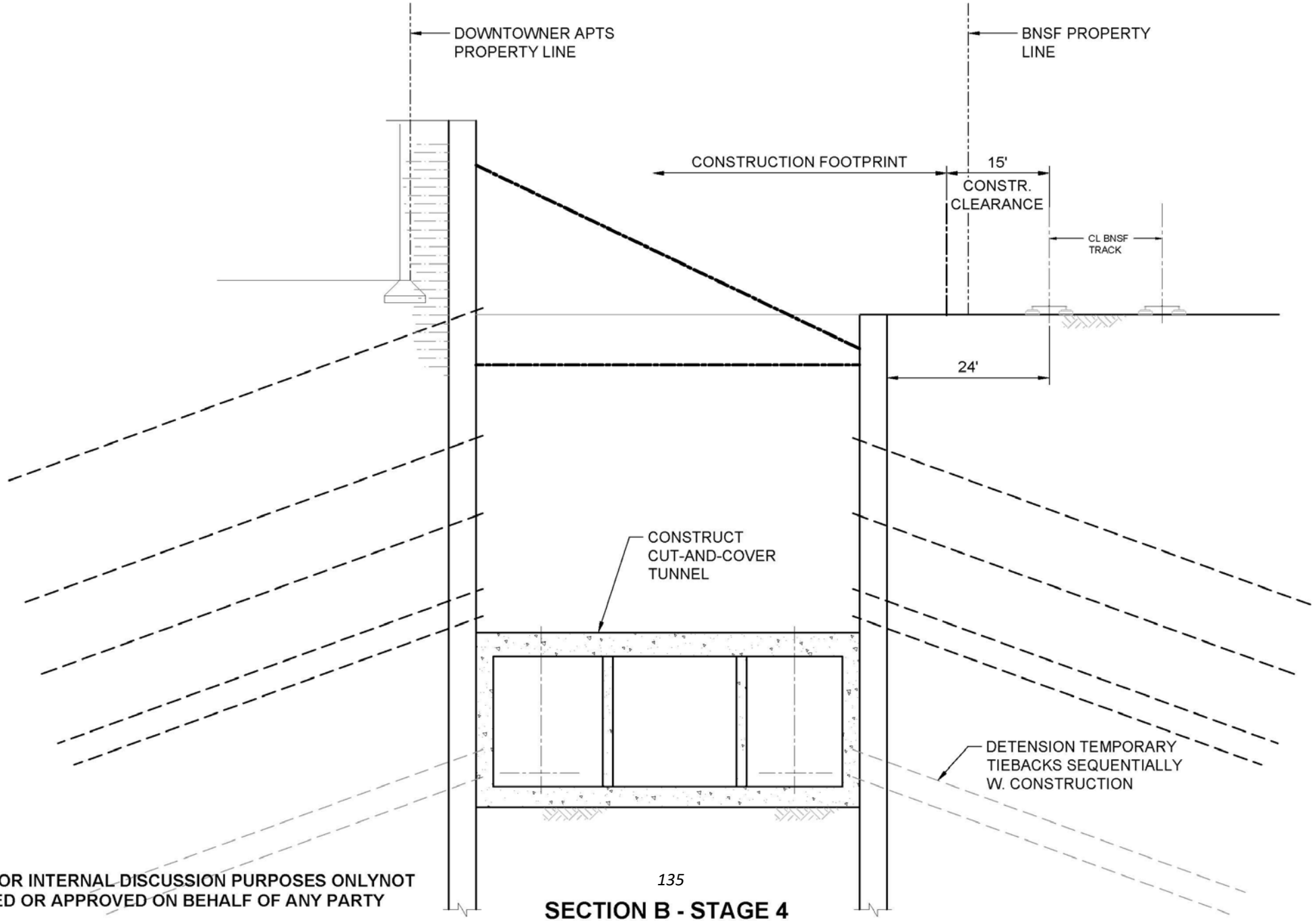
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134

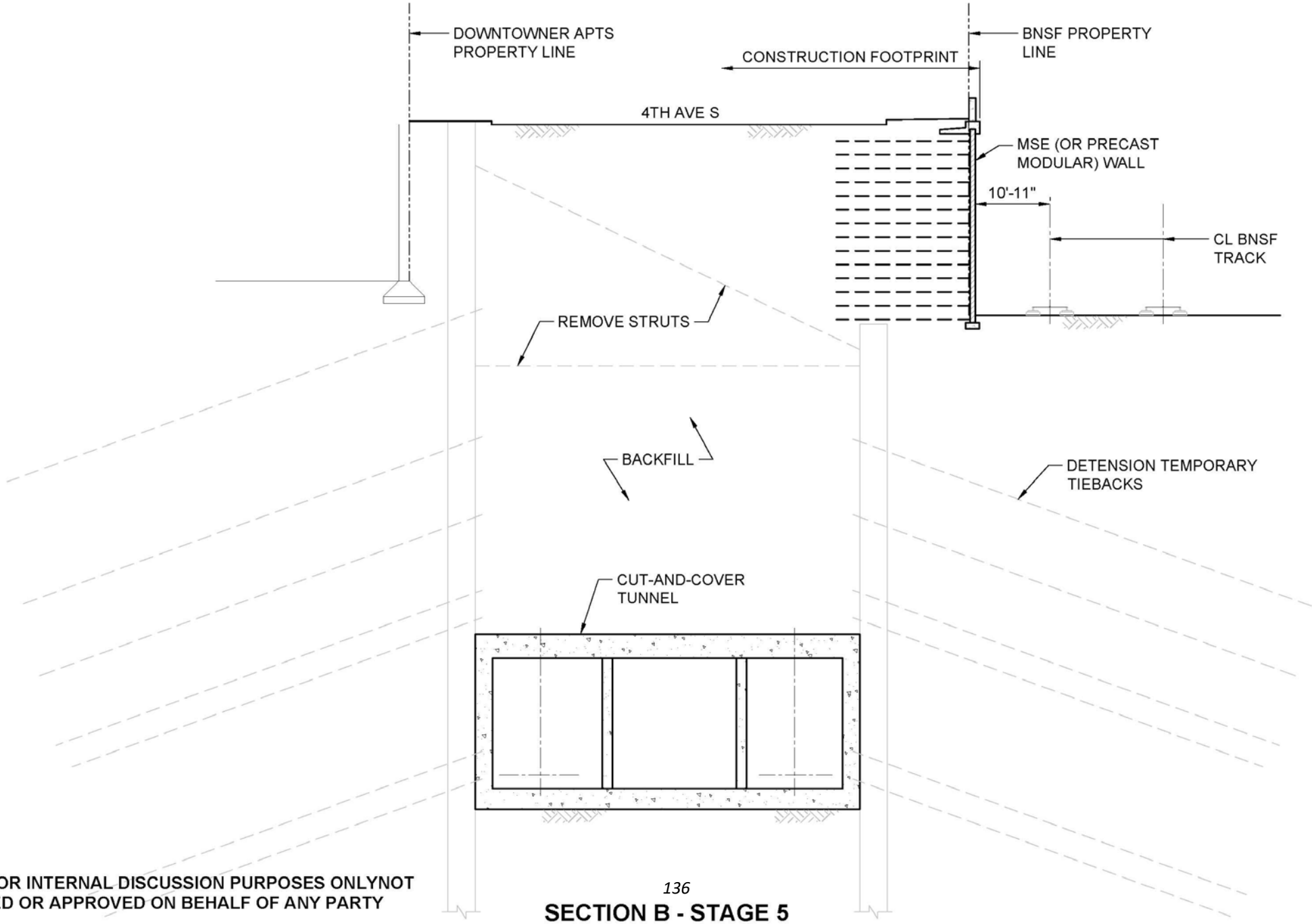
SECTION B - STAGE 3

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SECTION B - STAGE 4

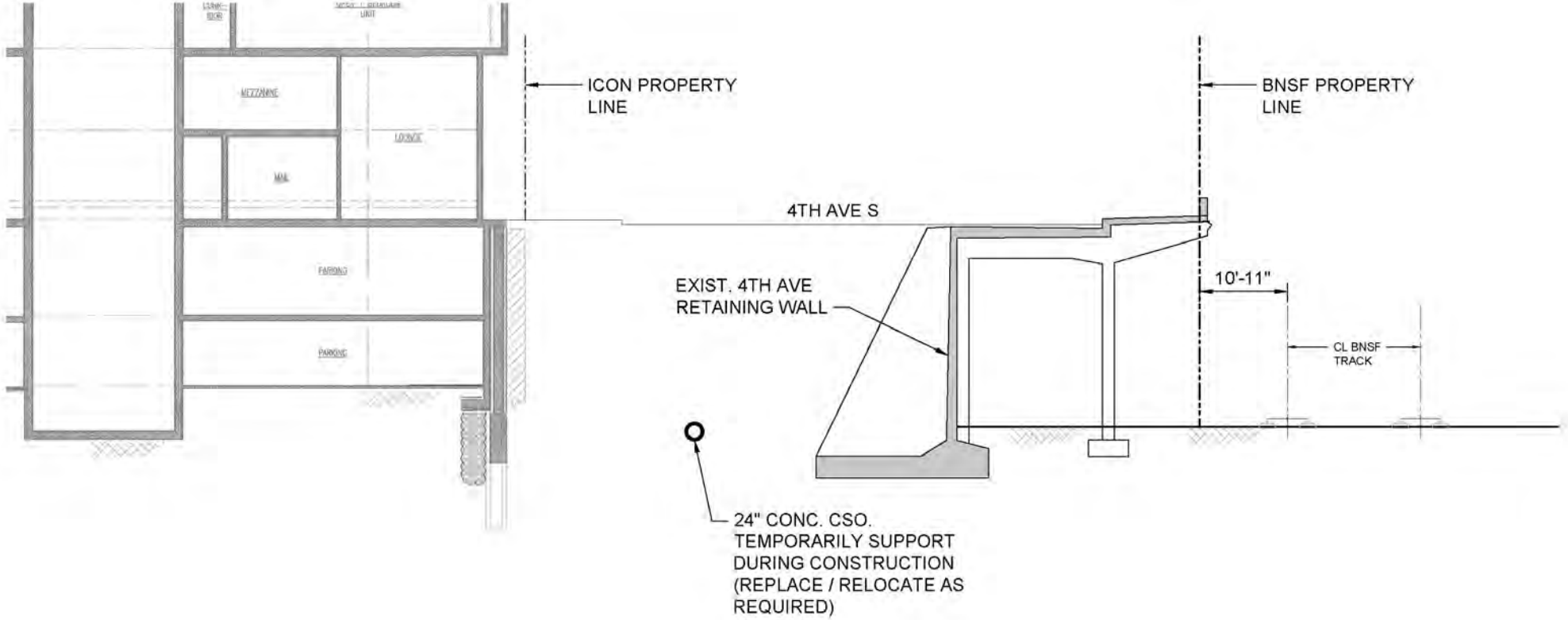
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136

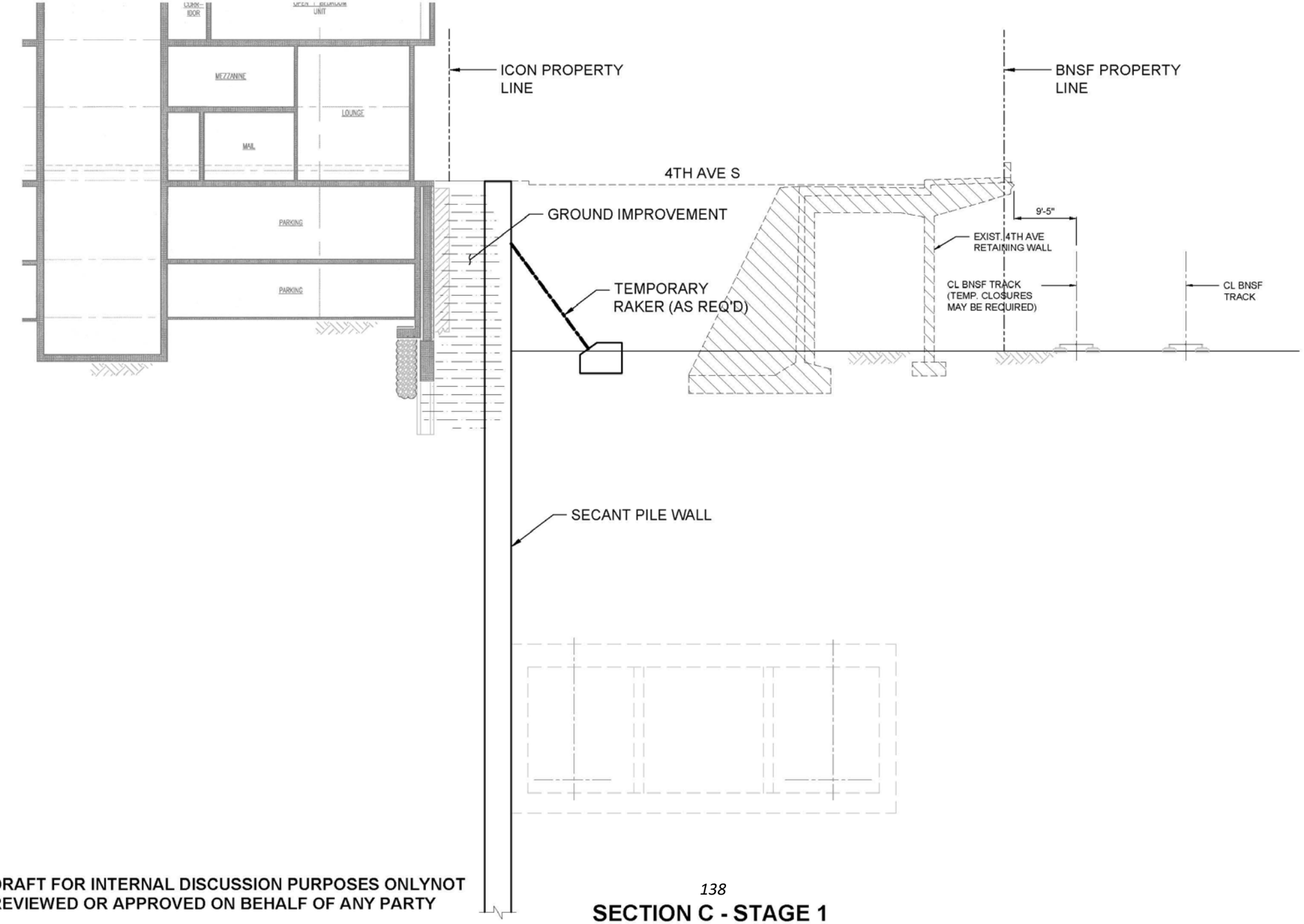
SECTION B - STAGE 5

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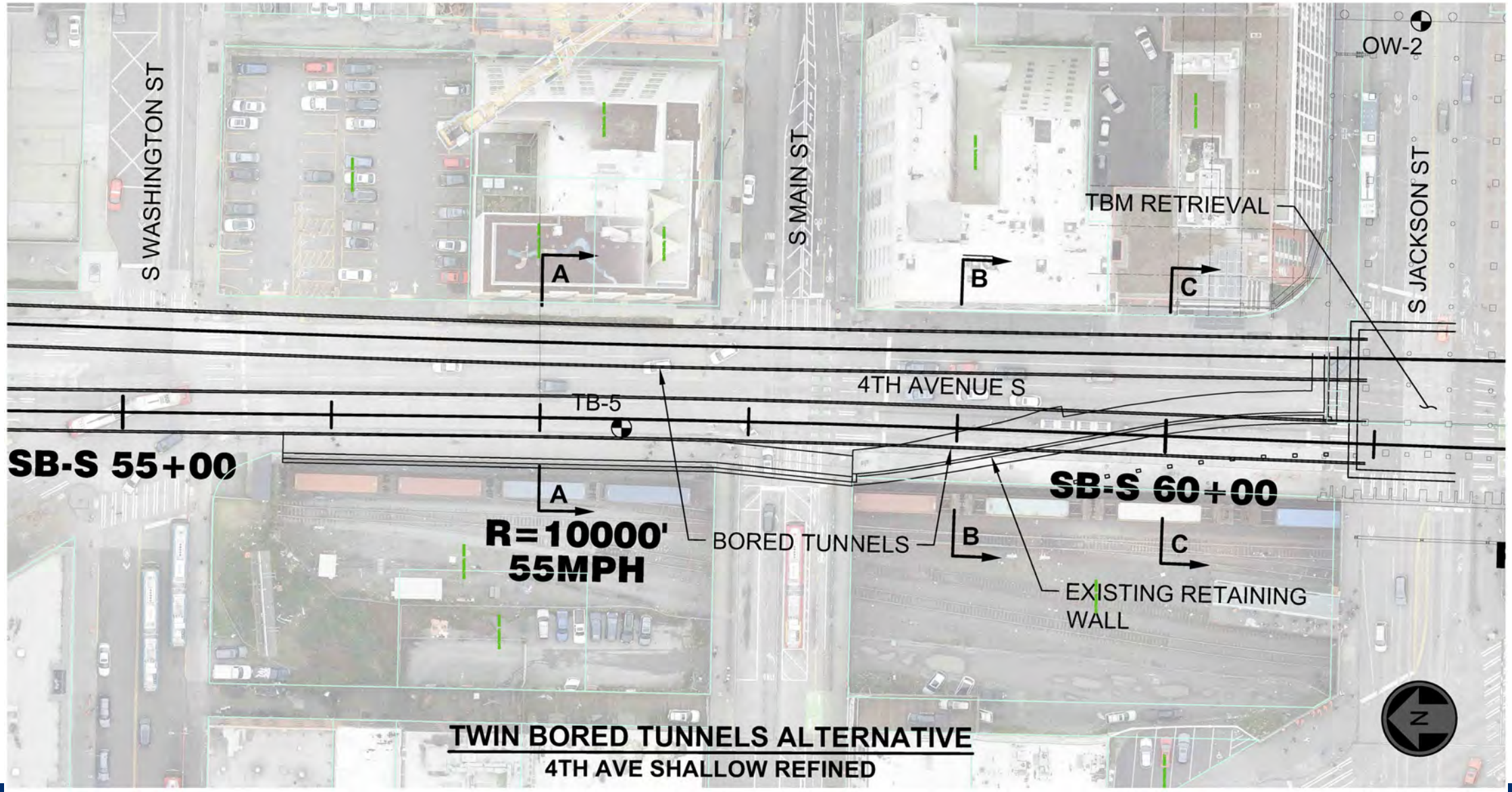
SECTION C - EXISTING CONDITION



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SECTION C - STAGE 1

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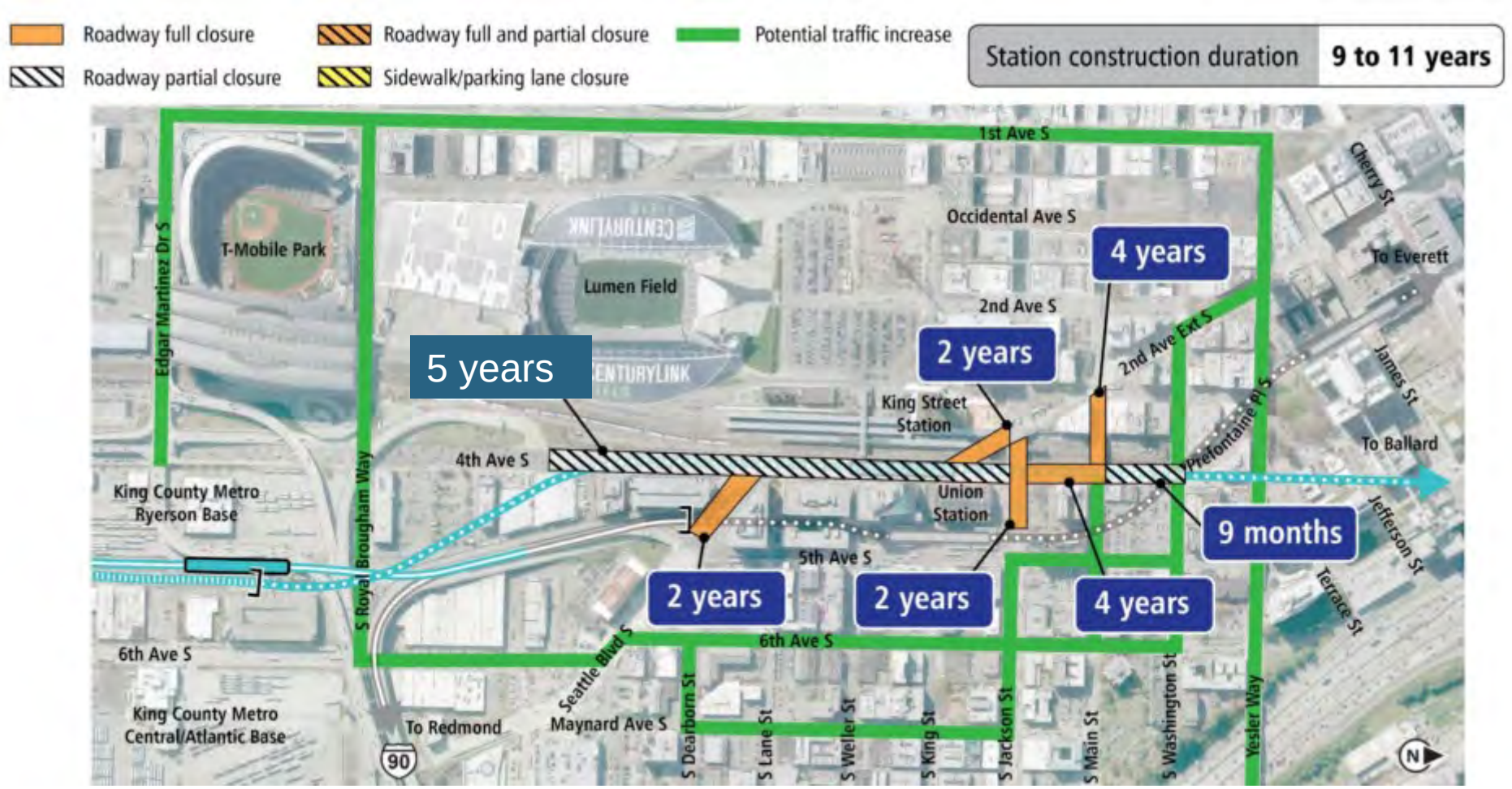
4th Shallow Summary

4th Shallow Summary

- Depth:
  - Station platform depth of approx. 80 ft
  - Cross under DSTT
  - Portal location S. Main Street
- Construction Approach:
  - Staged construction maintaining two lanes of traffic, stage west and east
  - “Top down” construction with new viaduct
  - 10 to 12 years station construction duration

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4th Shallow Summary - continued



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Construction Effects Summary

- Full Street Closures:
  - 4th Avenue S, S Main Street to S Jackson Street (4 years)
  - S Jackson Street, including Streetcar (2 years)
  - S Main Street (4 years)
  - Seattle Blvd S (2 years)
  - 2nd Avenue Extension S (2 years)
- Partial Street Closures:
  - 4th Avenue S, S Jackson Street to I-90 (5 years)
- Utility Relocations:
  - 48” Combined Sewer
  - 12” Water
  - Communication
- Construction adjacent to BNSF (secant pile wall)

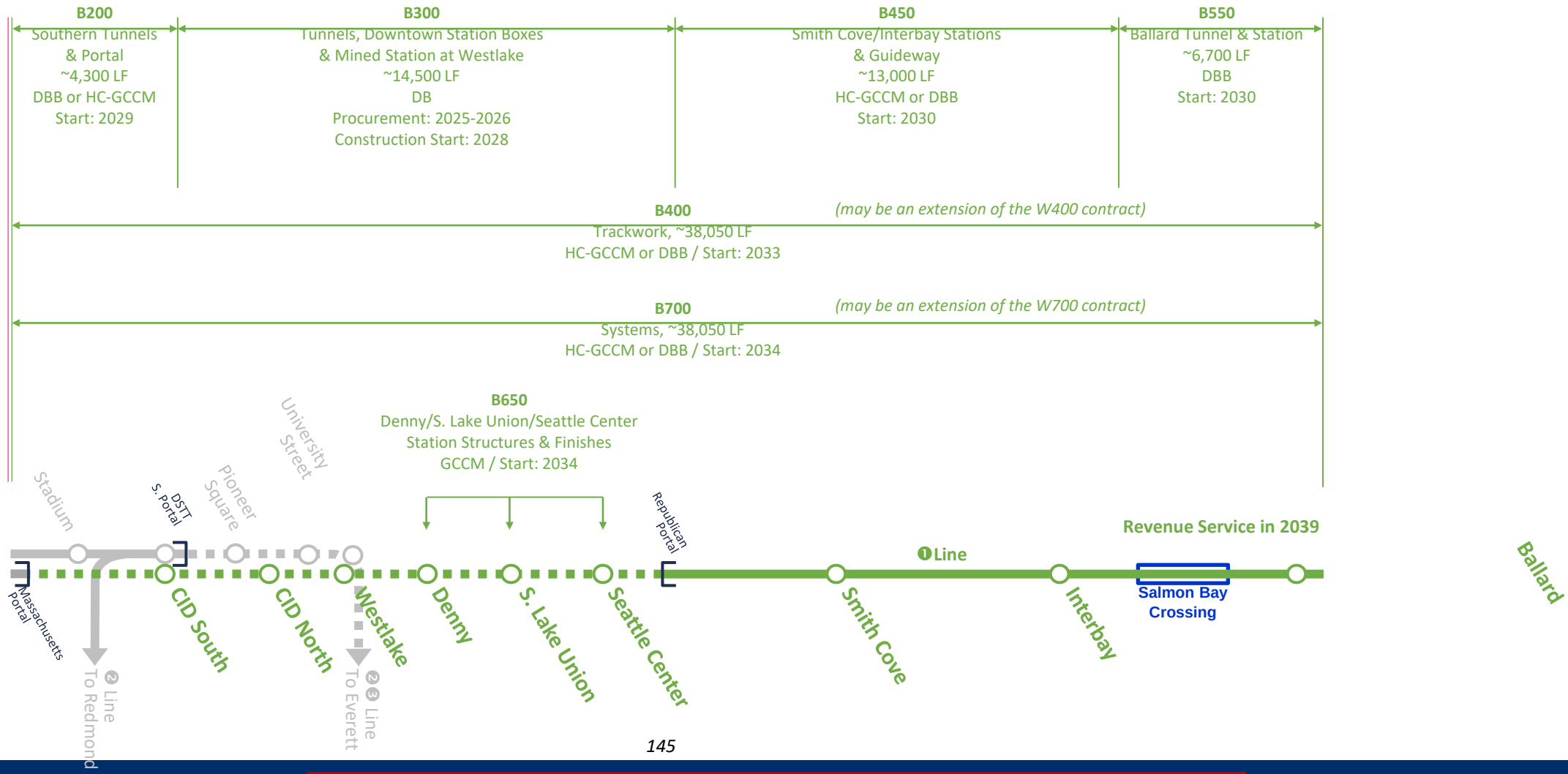
CONCEPTUAL
DRAFT – For internal discussion only. Not reviewed or approved on behalf of any party.

Construction Effects Summary

- Roadway bridge structure reconstruction:
  - 4th Avenue South
  - Seattle Boulevard South
  - S. Jackson Street
  - S. Main Street
- Roadway bridge potential retrofit:
  - S. Jackson Street, west of 4th Avenue South
  - 2nd Avenue Extension South
- Reconstruction of Union Station Plaza and facility south of Great Hall
- Settlement evaluation of buildings in close proximity to tunnel/station construction
- ICON Apartments (Two 2-month displacements)
- Bus bridge effects (70+ buses per hour needed)

CONCEPTUAL
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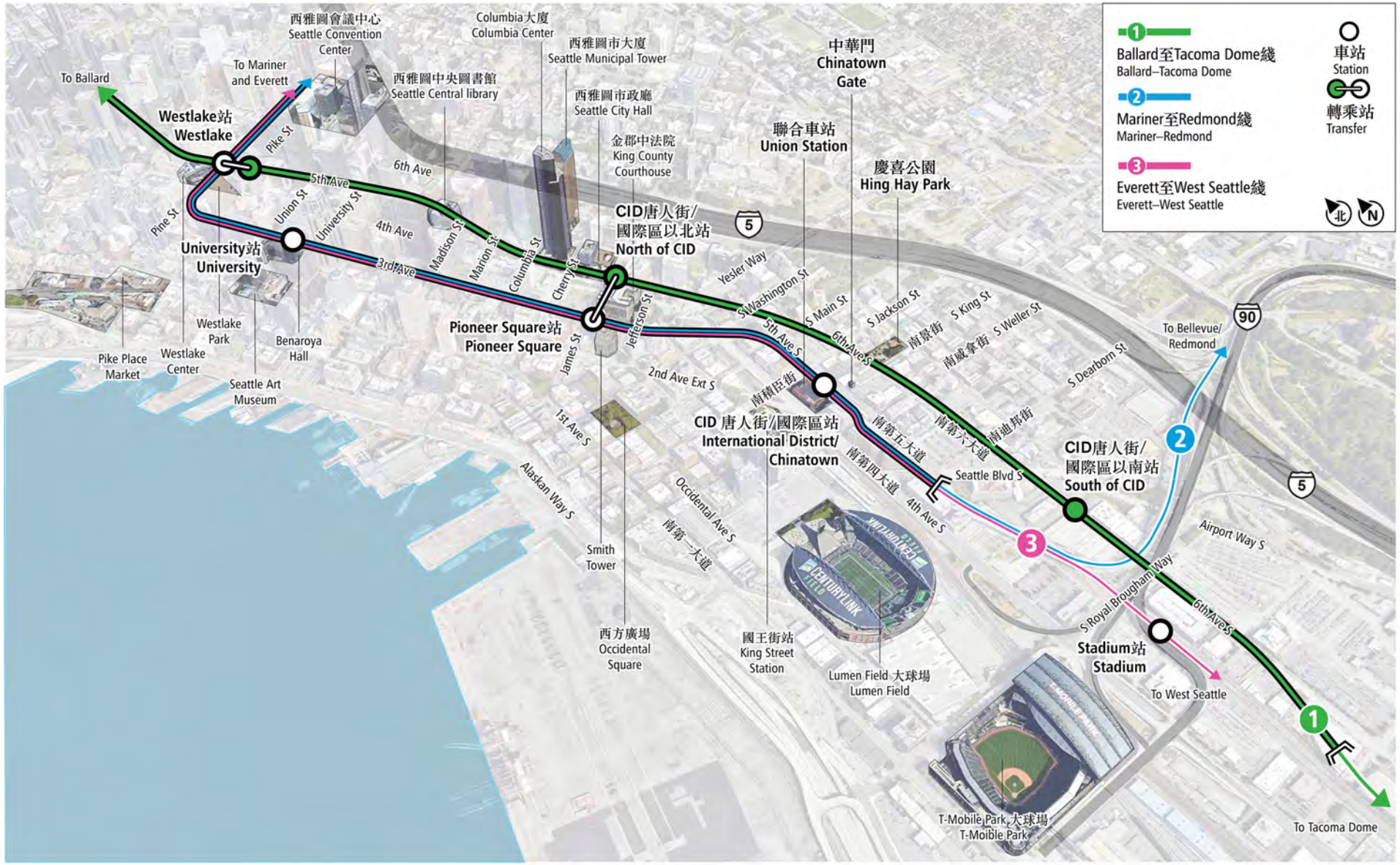
BLE Potential Contract Packages



Preferred Alternative for Ballard Extension not fully identified.
Packaging plan may change once a Preferred Alternative is finalized.

North of CID

North + South of CID (No Midtown)

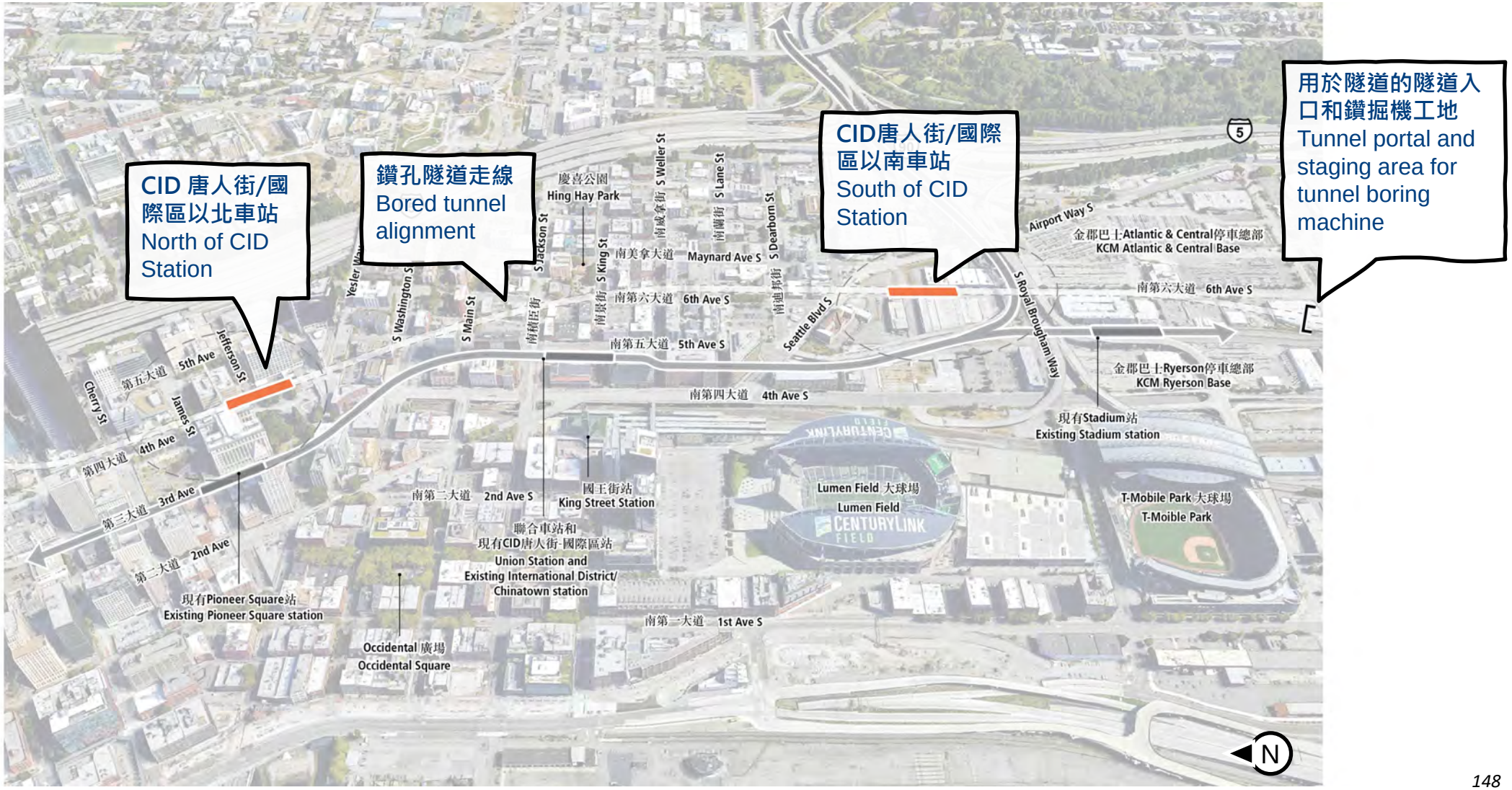


147

初步研究結果。分析仍在進行中，可能會作出變更 。
Preliminary findings. Analysis is ongoing and is subject to change.

SOUNDTRANSIT

North + South of CID: key features overview



148

初步設計概念。 設計仍在進行中，可能會作出變更 。
Preliminary concept. Design is ongoing and is subject to change.

SOUNDTRANSIT

North of CID and South of CID Status

- Conceptual design and DEIS documents in progress; due end of September
- North of CID (aka PSQ/Midtown Station)
  - 4.5 Alternative east of 4th Ave chosen
  - Ped connection from new station to DSTT PSQ Station above BNSF tunnel via Jefferson St chosen 8/3/23 (James St is alt)
  - Vertical shaft in Cherry St necessary
  - Conceptually similar to reference materials provided before this meeting
- South of CID (aka Seattle Boulevard Station)
  - Skewed station alignment connecting 6th Ave S across Seattle Blvd chosen; station shifted north, profile raised about 15 feet
  - 3 station access points
  - Permanent local roadway reconfiguration assumed

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North of CID Constraints

- Proximity to adjacent structures
- Maintain operations of Metro routes 3 and 4 (trolley wires)
- Limit construction traffic through CID neighborhood
- “Replaces” Midtown Station – needs to serve same area, including connection to Madison Rapid Ride G-Line
- Geotechnical considerations – future explorations planned late 2023
- Station platform must remain shallow; Sound Transit Board eliminated deep options

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North of CID Setting and Constraints

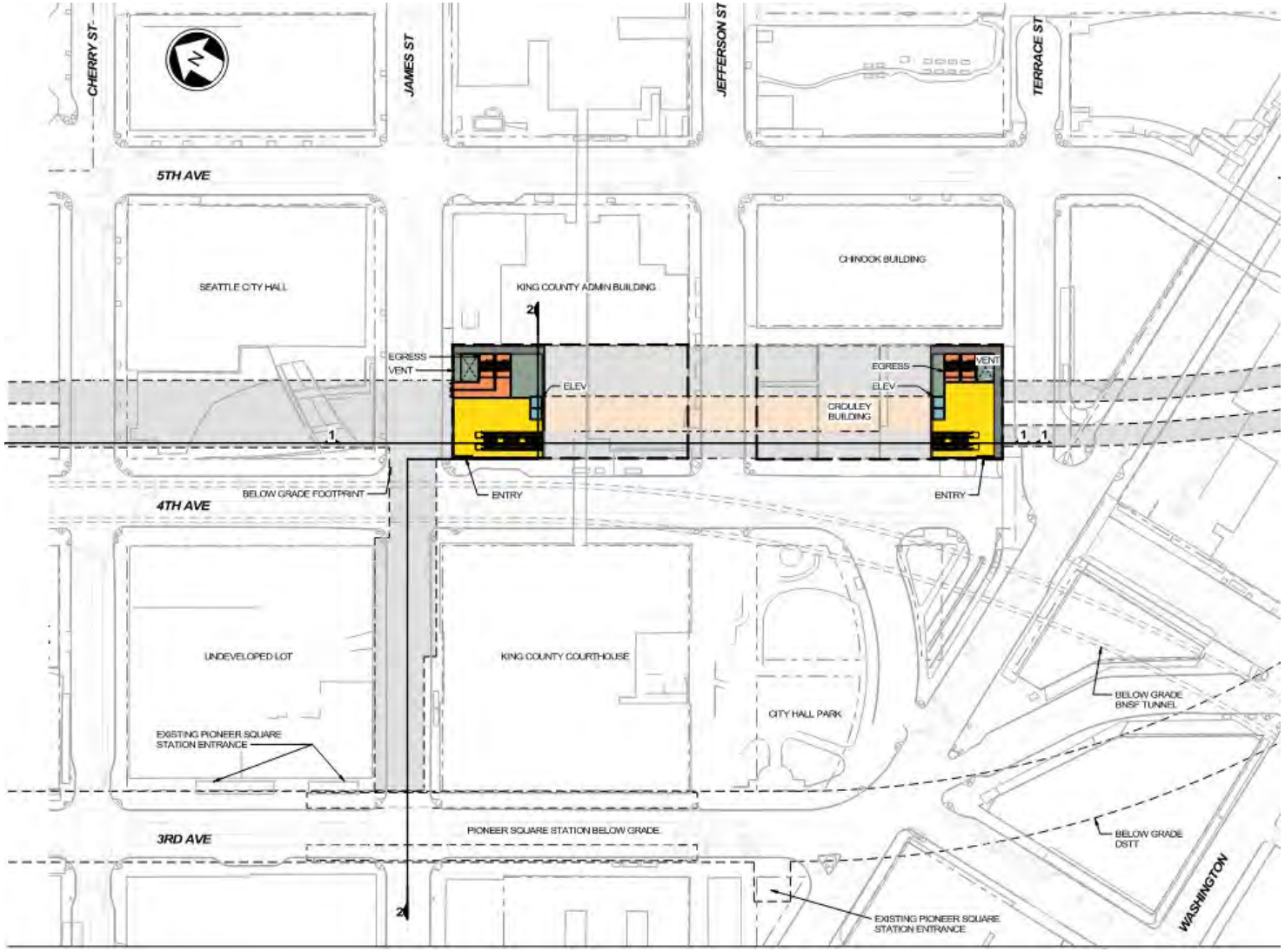


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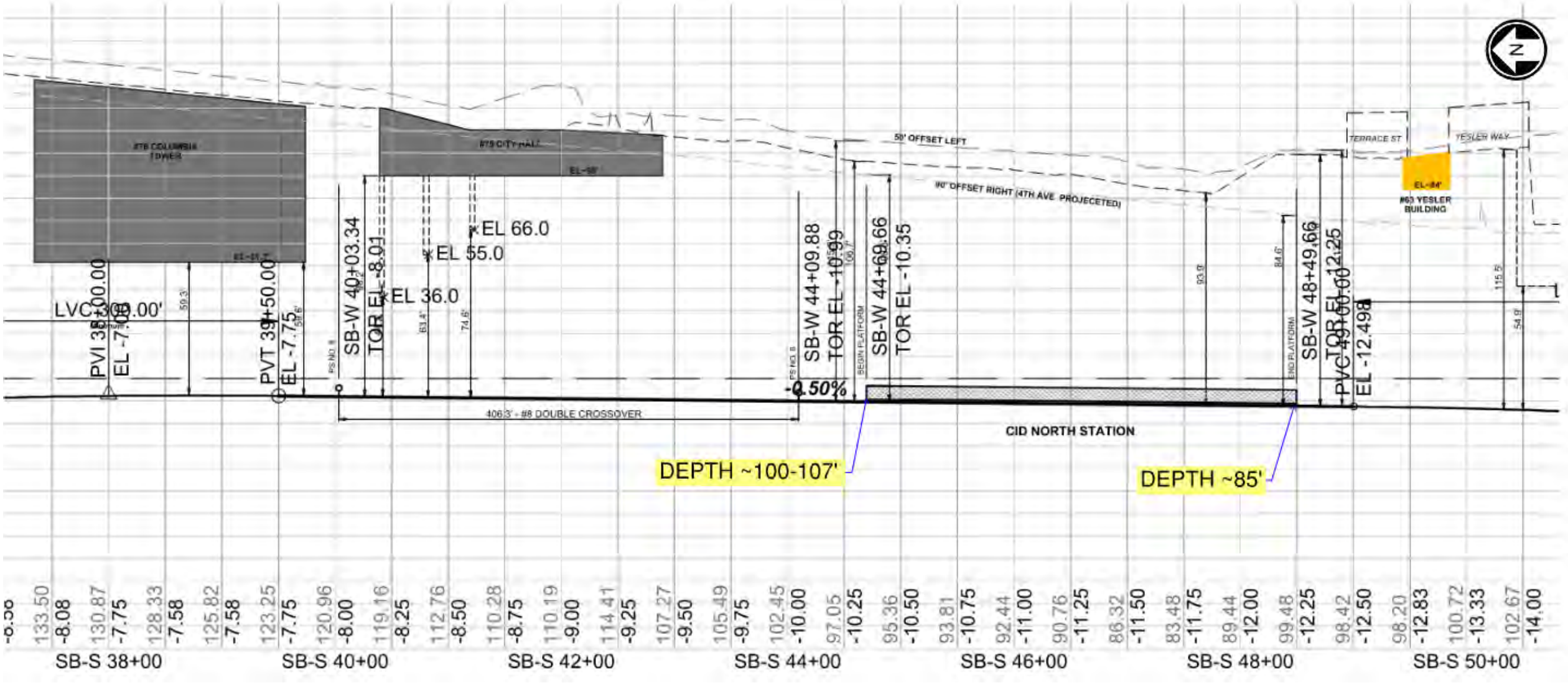
North of CID Architectural Station Plan



152

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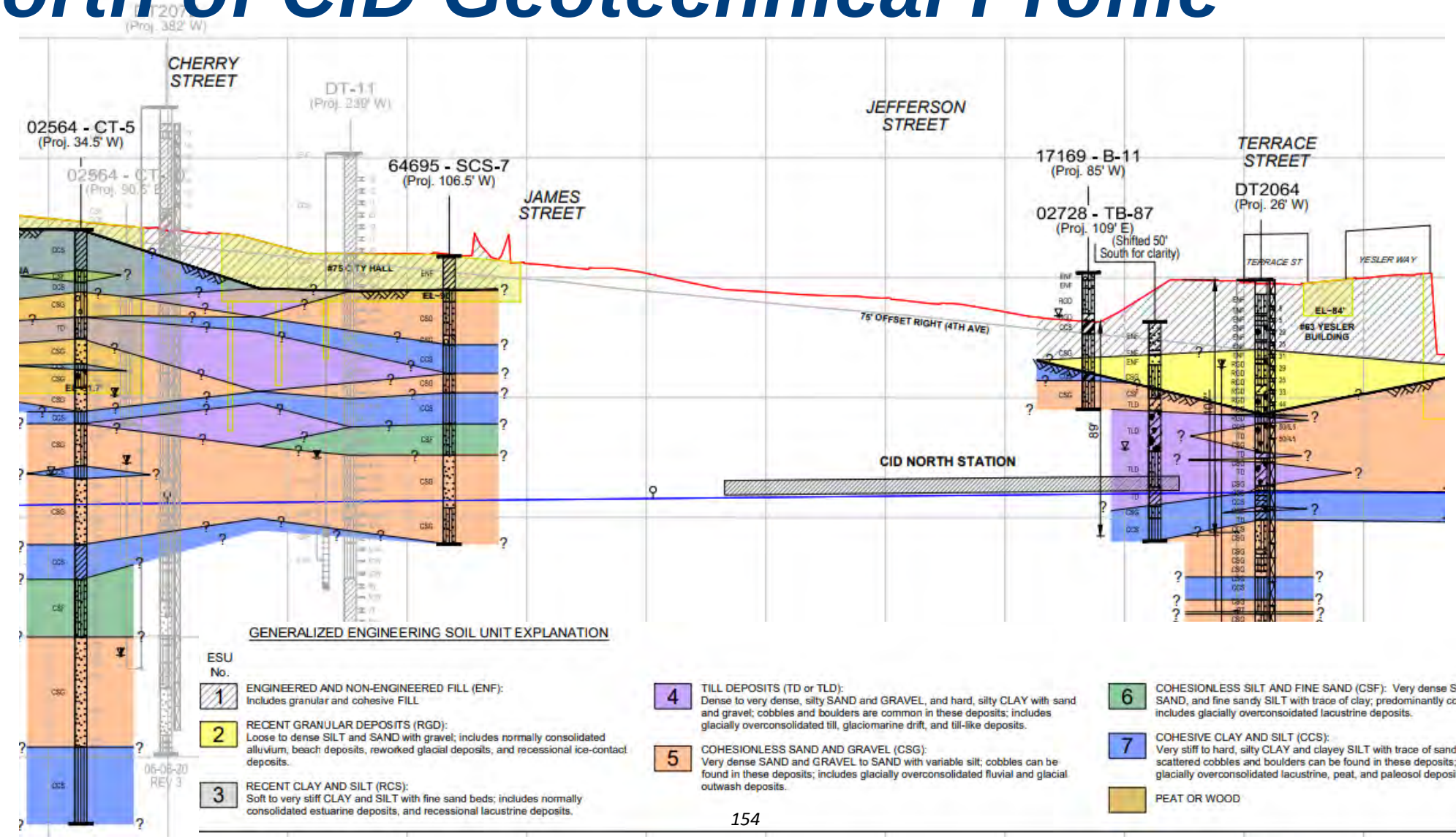
North of CID Profile



153

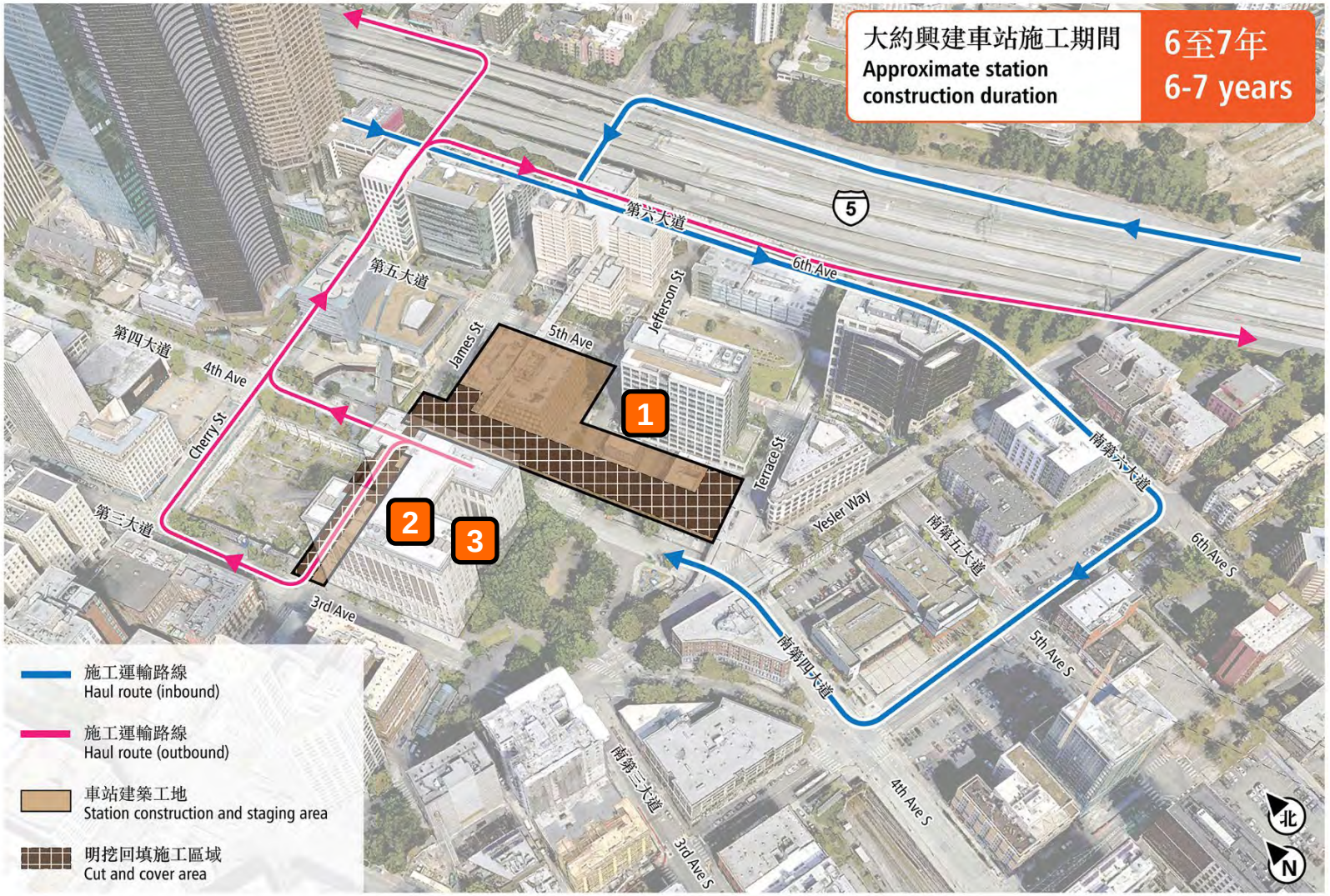
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North of CID Geotechnical Profile



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CID唐人街/國際區以北車站:施工時的影響
North of CID: potential haul routes



155

1 *搬遷金縣行政大樓和其他提供社會服務的建築物，包括Hotel Reynolds（工作釋放設施）和團體護理之家/公寓*
Displaces King County Administration Building and other buildings that house social services, including Hotel Reynolds (Work Release Facility) & Group Care Home/Apartments

2 *未發展物業的潛在車站入口機遇，需要與發展計劃協調*
Opportunity for a potential station entrance at undeveloped property, requires coordination with development plans

3 *可以暫時將無軌電車從 James St 轉移到附近的走廊（取決於車站格局設計）*
Could temporarily relocate trolley wire buses from James St to nearby corridor (depending on configuration)

在 12.14.22 研討會上分享
Shared at 12.14.22 workshop

初步研究結果。分析仍在進行中，可能會作出變更 。
Preliminary findings. Analysis is ongoing and is subject to change.

SOUNDTRANSIT

Construction Effects Summary

- Full Street Closures:
  - James Street between 3rd and 4th avenues (4 years) (potential)
  - Jefferson Street east of 4th Ave and west of Chinook building (6 years)
- Partial Street Closures:
  - East curb lane on 4th Ave between Terrace and James streets (6 years)
  - James Street at the intersection of James Street and 4th Ave (1.5 years)
- Property acquisitions, displacements, and environmental concerns:
  - Adversely affects four historic properties: KC Administration Building, 420 4th Ave, Hotel Reynolds, and Macrae Parking Garage
  - Potential closure of KC Courthouse south tunnel access

CONCEPTUAL
DRAFT – For internal discussion only. Not reviewed or approved on behalf of any party.

South of CID

South of CID Constraints

- Limit construction traffic through CID neighborhood
- Geotechnical considerations – future explorations planned late 2023
- Historic buildings – Wan Hau Foods, Inscape Cultural Center
- Building foundations – deeper basements and foundations informed alignment to within 6th Ave
- Maintain operations of mainline LRT
  - At cut-over south of station
- Station platform must remain shallow; Sound Transit Board eliminated deep options
- 16" HP gas, 16" W, 15"-30" CS mains along 6th Avenue S; future SCL Mass-Denny Substation transmission ductbank along Seattle Blvd and 6th

South of CID Setting and Constraints

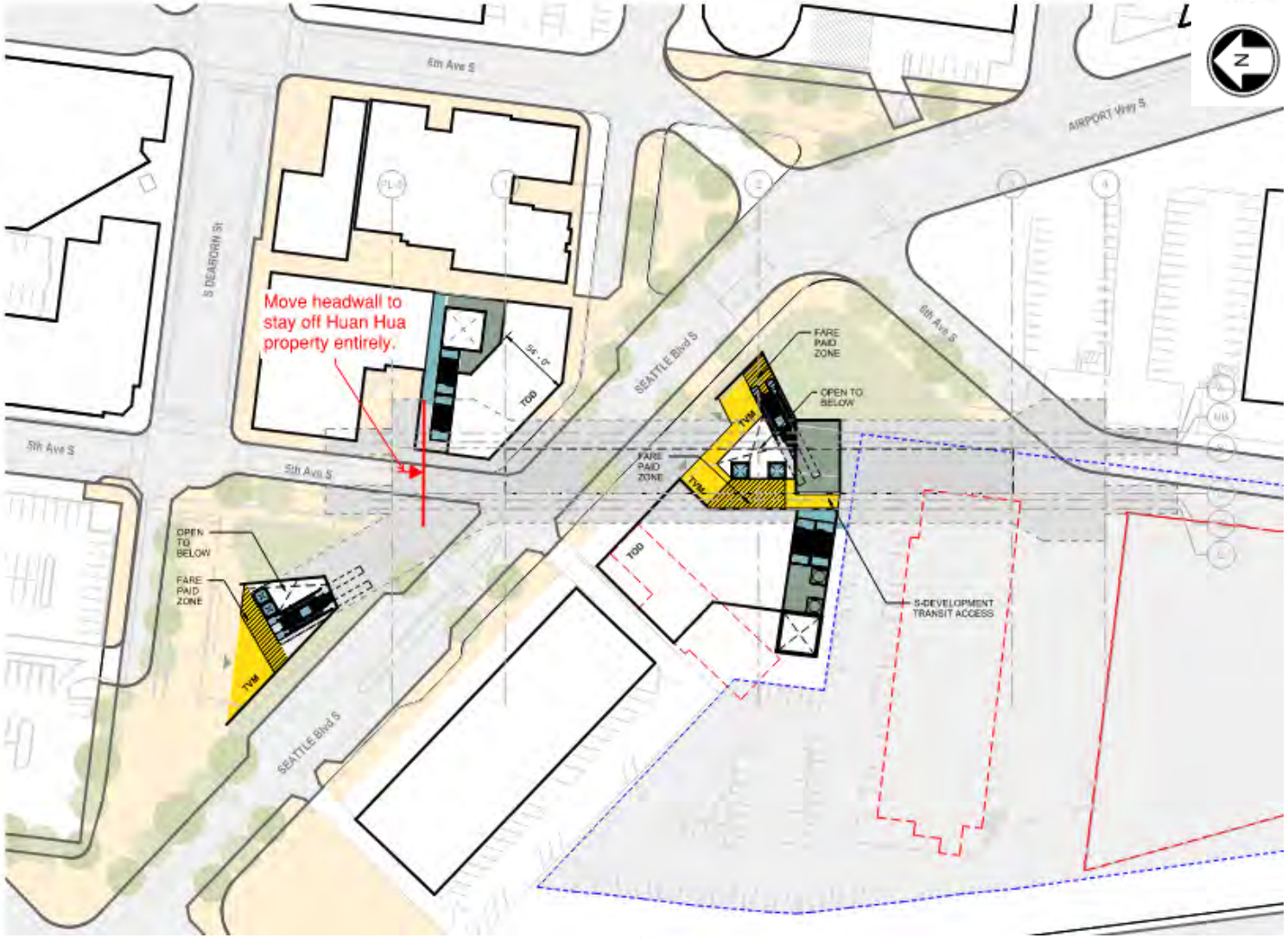


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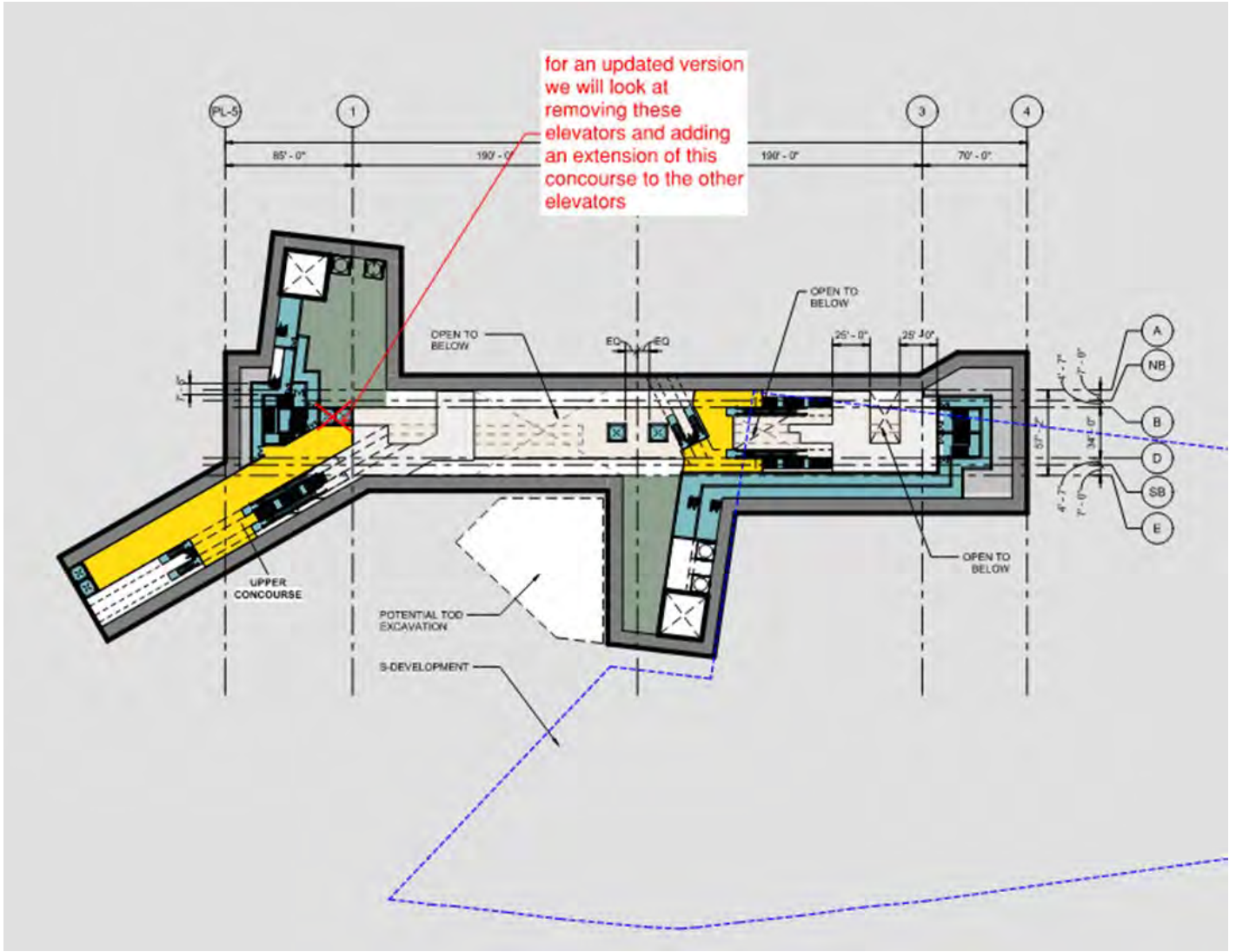
South of CID Architectural Surface Plan



160

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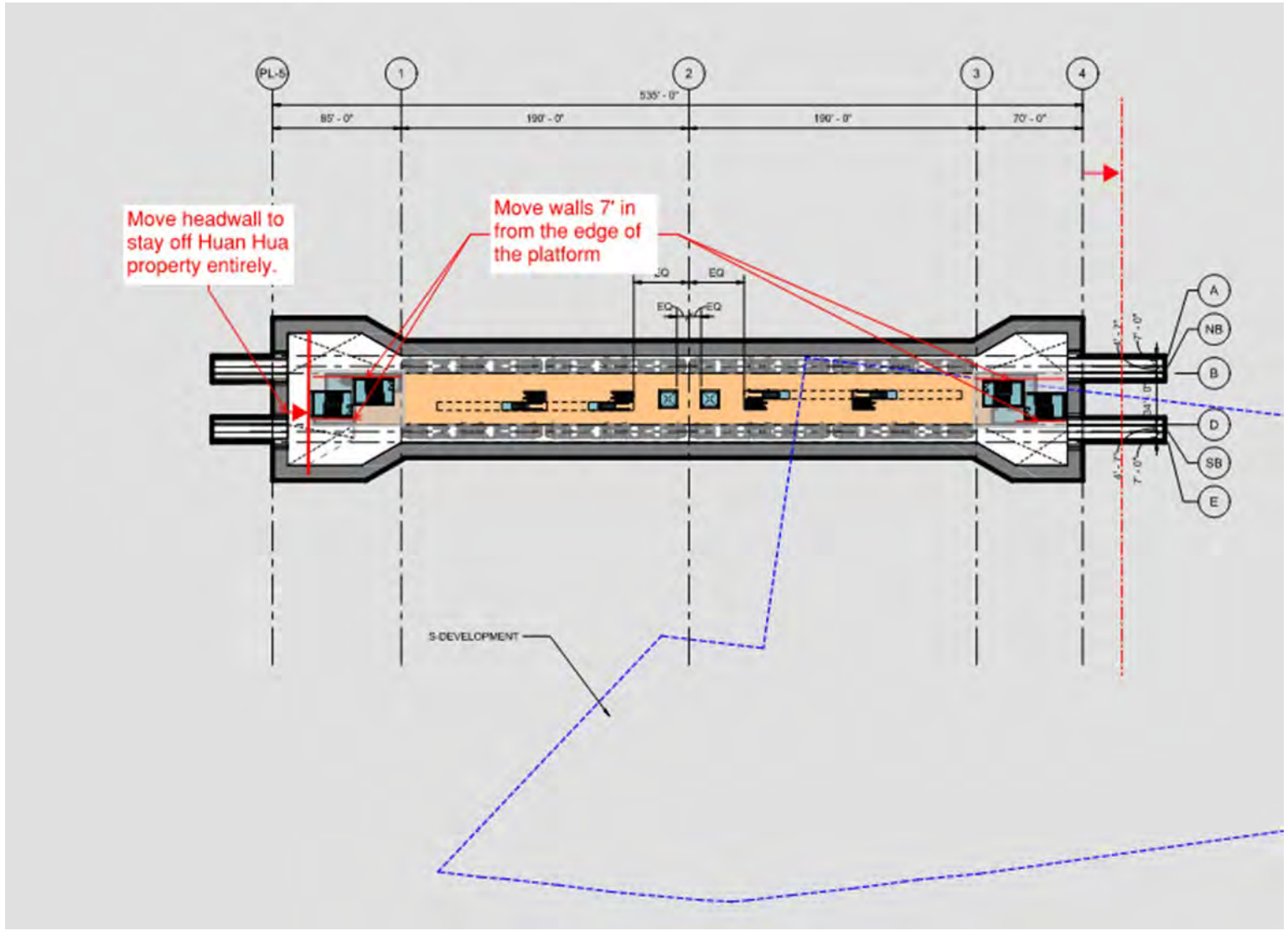
South of CID Upper Concourse Plan



161

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South of CID Platform Plan

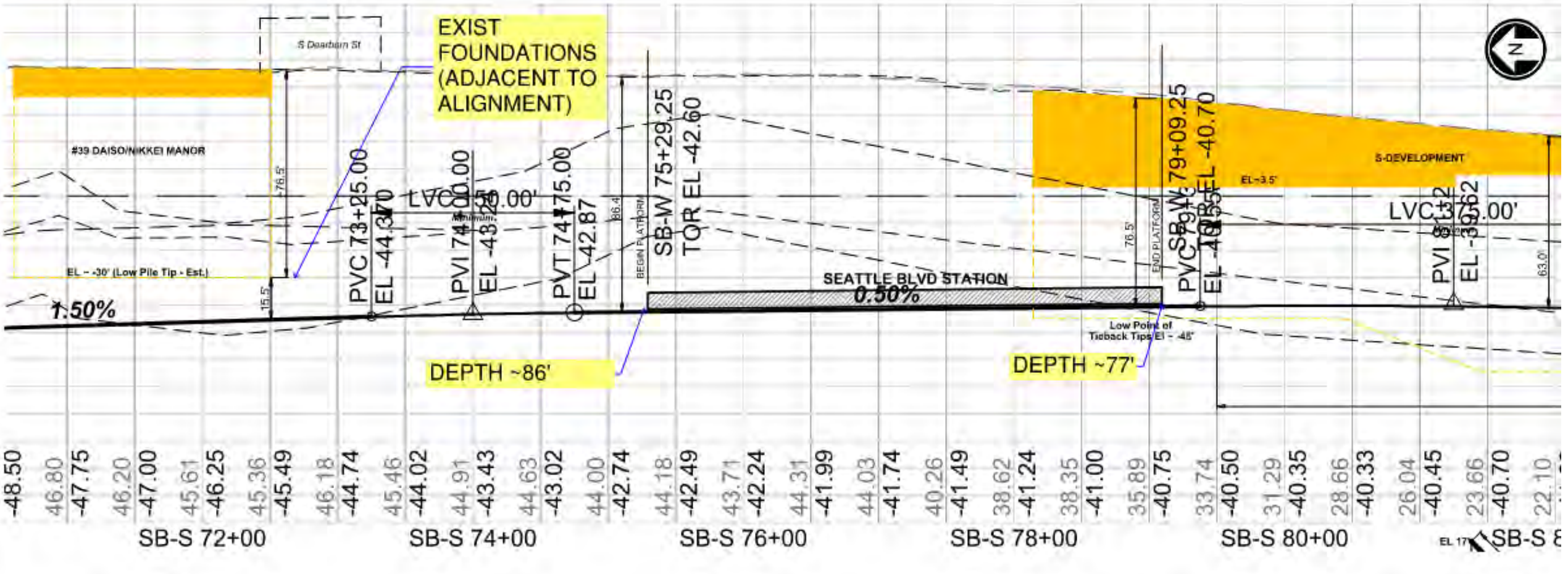




162

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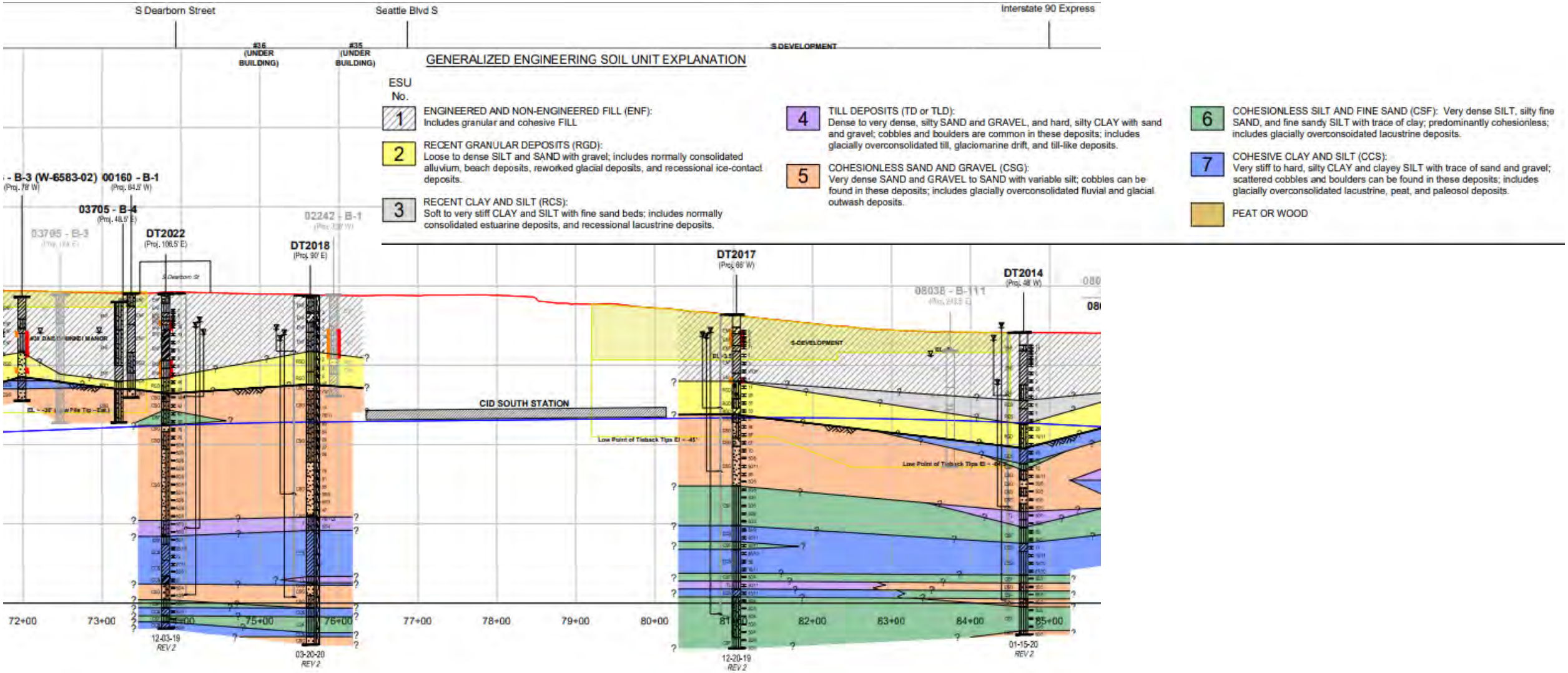
South of CID Profile



163

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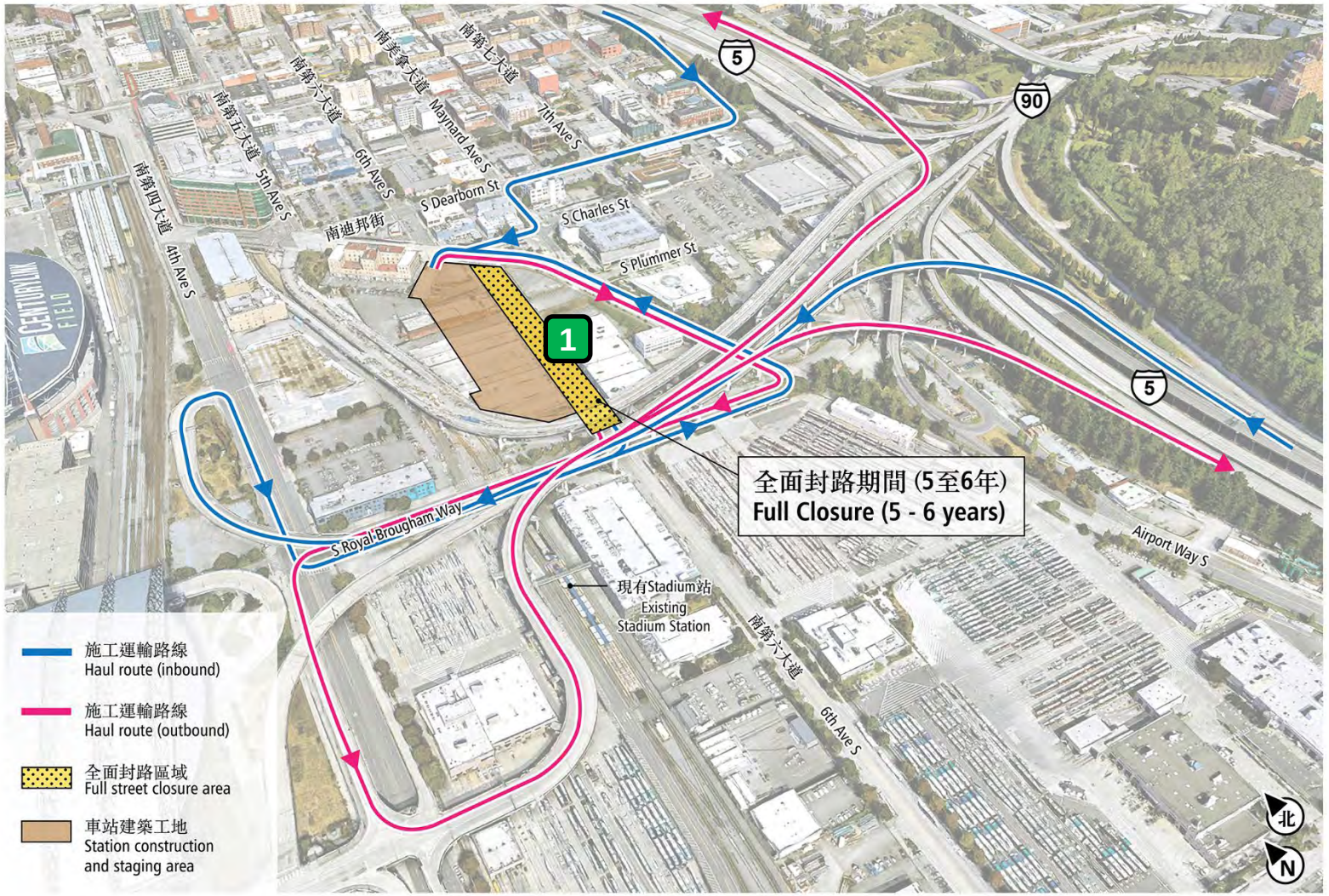
South of CID Geotechnical Profile



164

Draft Presentation for Meeting Discussion Purposes Only; Do Not Distribute

CID唐人街/國際區以南車站:交通影響
South of CID: potential haul routes



165

1 *施工需要完全關閉 Seattle Boulevard S 和 S Royal Brougham 之間的南第六大道，這對整體交通和道路封閉影響較小*

Construction requires full closure of 6th Ave S between Seattle Boulevard S and S Royal Brougham, which has fewer overall traffic and road closure implications

在 12.14.22 研討會上分享
Shared at 12.14.22 workshop

初步研究結果。分析仍在進行中，可能會作出變更 。
Preliminary findings. Analysis is ongoing and is subject to change.

SOUNDTRANSIT

Construction Effects Summary

- Full Street Closures:
  - 6th Avenue S between Seattle Blvd S and Royal Brougham Way S (5-6 years)
- Utilities:
  - High pressure underground gas line along 6th Avenue
- Trolley Buses entering/exiting Atlantic Base

CONCEPTUAL
DRAFT – For internal discussion only. Not reviewed or approved on behalf of any party.

North + South of CID TBM Utilization Sequencing

IDEA EVALUATION

IDEA EVALUATION

The ideas generated by the SA team were carefully evaluated, and project-specific attributes were applied to each idea to assure an objective evaluation.

EVALUATION PROCESS

The SA team generated and evaluated ideas regarding how to perform the various project functions using other approaches. The idea list was grouped by function or major project element. Each idea was evaluated with respect to the functional requirements of the project. Performance, cost, time, and risk may also have been considered during this evaluation.

IDEA SUMMARY

All of the ideas generated during the Creativity Phase using brainstorming techniques are recorded on the following pages. Ideas received an idea code based upon the function statement under which it was brainstormed. The following tables indicate the functions related to each idea code.

4TH Ave. Shallow Option

Idea Code	Related Function
AB	Access Building
AC	Access Construction
DT	Detour Traffic
FC	Facilitate Construction
M	Miscellaneous Ideas
MC	Maximize Constructability
MSI	Minimize Surface Effects
PR	Protect Railroad

North & South of CID Alignment

Idea Code	Related Function
CT	Connect Tunnels
FC	Facilitate Construction
M	Miscellaneous Ideas
MA	Maintain Access
MI	Mitigate Impacts
MO	Mitigate Obstructions
MSI	Minimize Surface Effects
MT	Maintain Traffic
RS	Remove Spoils

IDEA SUMMARY LIST

Access Building | 5

AB-1
Develop access via adjacent parking garage to serve Icon Building and maintain residents



AB-2
Develop multiple access points for Icon bldg - Ped. access from North alley, through lower wall, garage access from Union Station garage, temporary bridge access during construction, sidewalk use for ped access. access from Jackson



AB-3
Develop new street access for Icon Bldg. off of Jackson St. - (through retail space - used to be Bartell's Drugs). Require internal building mod. Maintain residents



AB-4
Develop temporary access ramp for Icon building - 100-feet of distance for ramp

AB-5
Install temporary hydraulic vehicle lift to access Icon Bldg. for garbage/maint. access



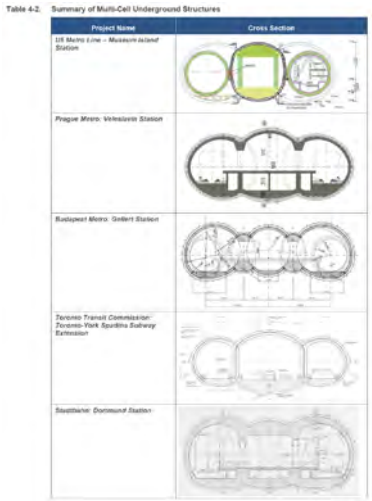


Minimize Surface Impacts | 3

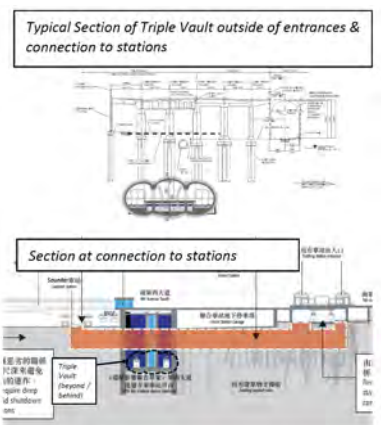
MSI-2
(D. Reda - GZ)
Alt. Concept to station box & running tunnel
- Reduced excavation
- Reduced Materials
- Reduced impact to viaduct (viaduct demo limited to station entrance locations)

MSI-3
(D. Reda - GZ)
Alt. Concept to station box shown is based on Veleslavin Station; with configuration of piles to station, the Gellert Station might provide a better overlap.
- Ends of piles would be integrated into the SEM initial lining; columns to be located under existing viaduct piles

MSI-4
(D. Reda - GZ)
Temporary Access Shaft from Union Station basement for early access for SEM Tunneling
- potential to remain as emergency egress adit at south end of platform



MSI-2



MSI-3



MSI-4

Minimize Surface Impacts | 5

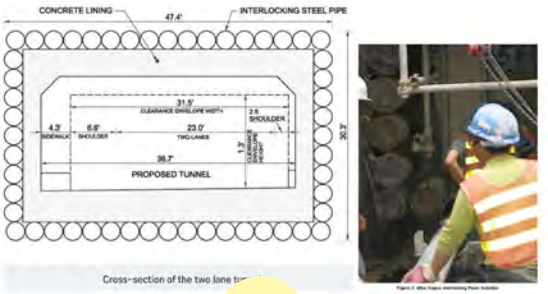
MSI: Minimize Surface Impacts, Bypass Structure, Maintain existing 4th Ave. Viaduct and construct rail alignment under it

MSI-5
(D. Reda - GZ)
Alt. Concept for Pipe Box is also possible
- Reduced excavation
- Reduced Materials
- Reduced risk
- Groundwater Control

MSI-6
(D. Reda - GZ)
Alt. Concept for Pipe Box is also possible for Running Tunnel Tangent Track where sufficient cover exists

MSI-7
(D. Reda - GZ)
Alt. Concept for Pipe Box is also possible
- Reduced excavation
- Reduced Materials
- Reduced risk
- Groundwater Control

MSI-8
(D. Reda - GZ)
Alt. Concept for Pipe Box outside of station entrances and/or TBM retrieval shaft

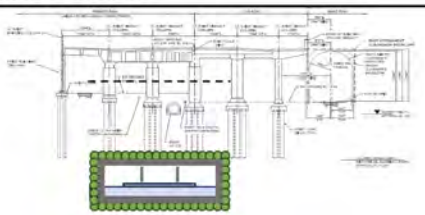


MSI-5&6



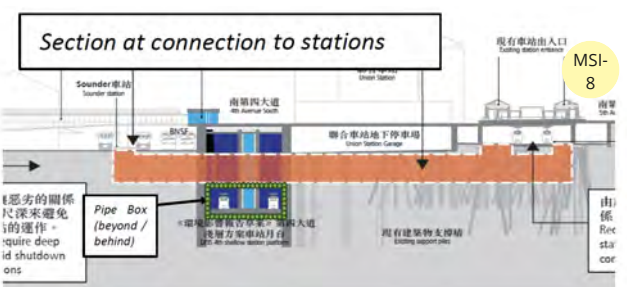
Typical Section of Pipe Box outside of entrances & connection to stations

MSI-7



Section at connection to stations

MSI-8



Protect Railroad | 8

PR-1
Request/ negotiate a waiver of the moratorium (allowed by BNSF rules)

PR-2
Implement measures that prevent shut down

PR-3
Provide temporary fencing/protection for minor impacts.

PR-4
Cranes placed on east side should be able to be placed so as not to be in danger of fouling the track.

PR-5
Use a sheetpile or other protective shoring system adjacent to BNSF tracks, then construct slurry walls on West side

PR-6
Coordinate schedule and key activities with BNSF Operations.

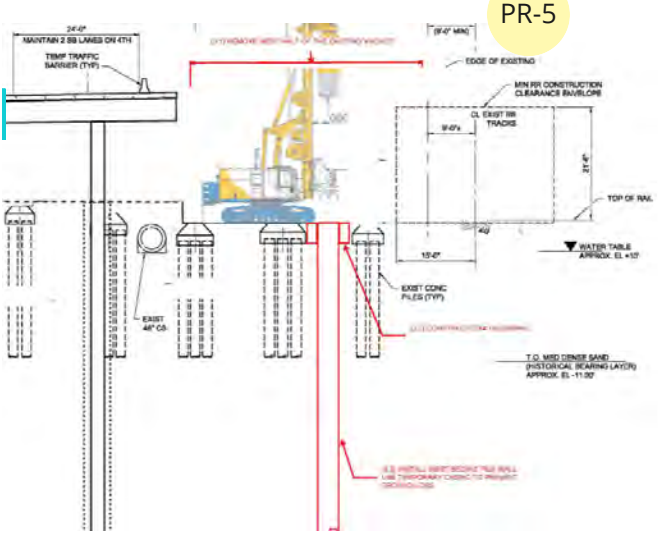
PR-7
Scheduled demolition immediately adjacent to BNSF track needs to assume a much slower demo rate

PR-8
Revisit slurry walls with BNSF. This methodology has improved over the years and is becoming more accepted and used.

Detour Traffic | 1

DT-1
Consider counterflow lanes for AM/PM peaks on 4th Ave.

PR-5



Access Construction | 2

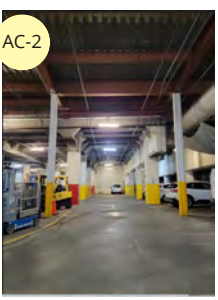
AC-1
Can access be created through Union St parking garage? Is there headroom for cement trucks or dump trucks?

AC-2
gate from garage to beneath 4th Ave at Seattle Blvd

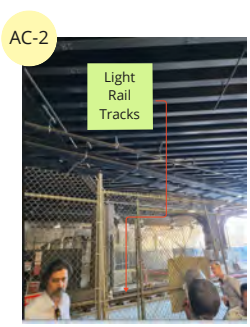


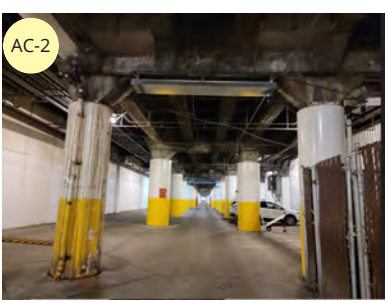












Facilitate Construction | 5

FC-1
Construct Stage 3 after stage 1 and concurrently start low headroom slurry walls in Stage 2 to maintain 4th Ave between Jackson and Seattle

Comments: Requires use of low-headroom slurry construction equipment

FC-2
Combine Stage 1 and 2. One traffic shift east-west for entire length up to Jackson

FC-3
Construct Stage 3 concurrent with Stages 1 & 2

FC-4
Construction south west end of 4th Ave portion first and incorporate access from edge of BNSF yard.

FC-5
The 4th Ave retaining wall south of Seattle Blvd appears to be independent of the support for Seattle Blvd. / 4th Ave intersection. Create a ramp on the east side of 4th Ave beginning 400 ft south of Seattle Blvd and ramp down to the grade below 4th Ave. while continuing to install the SOE in Stage 1.



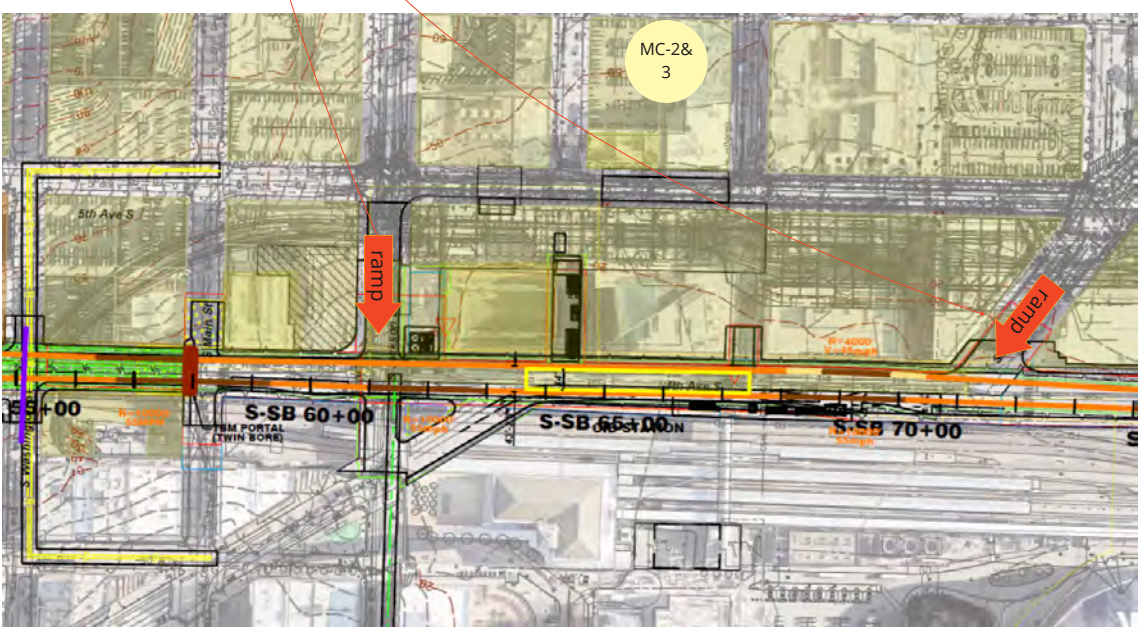


Maximize Constructability | 3

MC-1
Allow a full closure of 4th Ave. and construct in one stage

MC-2
Consider closures at Jackson / Seattle Blvd. to facilitate construction access for Stages 2/3 to run concurrent with Stage 1. Maintain two-lanes open on 4th Ave.

MC-3
Develop temp. ramps at Seattle Blvd. and/or Jackson St. to facilitate construction



Miscellaneous Ideas | 10

M-1
consider permanent viaduct as single main span or fewer spans. Lots of short spans in current configuration.

M-2
Consider procuring/ developing a nearby disposal site for excavated soil (possibly in the bay?) to minimize haul traffic.

M-3
Construct Main St bridge off alignment and slide into place.

M-4
Lighten up superstructure of viaduct (ie steel) to minimize foundation design (and work)

M-5
Brainstorm a practical detail for shaft to column connection (deep in temp casing). Or modify design to extend the shaft casing.

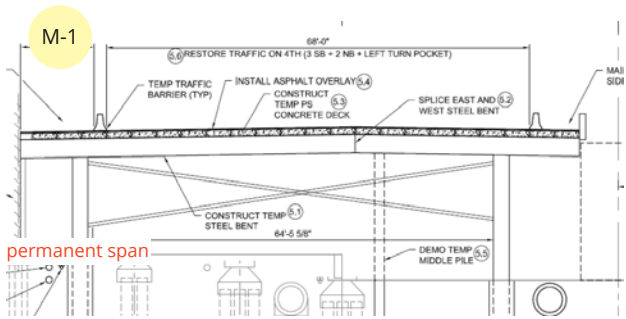
M-6
Design viaduct to make use of prefabricated components as much as possible ("cookie cutter").

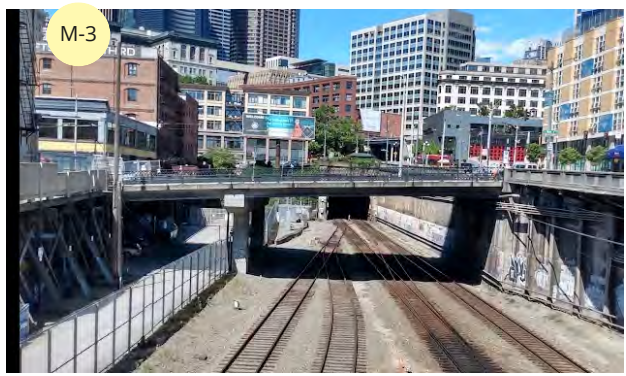
M-7
Explore eliminating one bent line in the middle and demolish the other middle bent line after connecting cross beam so there are no columns up through the station

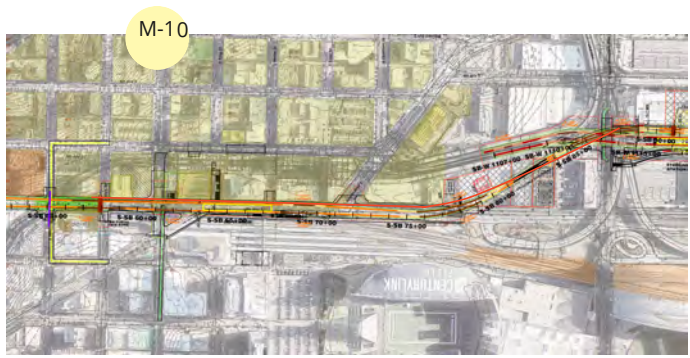
M-8
Explore eliminating one bent line (in the middle section) by designing a fixed full moment splice between cross beams.

M-9
Consider utilizing precast box beams for spans (30'). Shoot for legal weight. Or consider prefabricated steel superstructure members.

M-10
Shift alignment east off of 4th Ave. through Union Station garage







Maintain Access | 1

MA-1
Modify SOE to accommodate truck turnaround via alley

Remove Spoils | 2

RS-1
Move mucking to CID South to open TBM Tunnel South for Cross Passage and Tunnel Invert

RS-2
Muck out of one tunnel and begin cross passage construction through the other

Maintain Traffic | 1

MT-1
A temp. shaft at Cherry Blvd. is better than James for Traffic

Mitigate Obstructions | 1

MO-1
Early utility work package

Connect Tunnels | 1

CT-1
Ground freezing would be the team's preference





Mitigate Impacts | 7

MI-1
(D. Reda - GZ)
SEM Cavern Excavation Refs. from Chinatown Station in San Francisco
*dates are approx. and to be viewed only as context for evaluating WSBLE cavern high-level program

MI-2
(D. Reda - GZ)
SEM Cavern Section from ACE Phase; assumed this is the same cavern followed for the X-Over
- the triple-cell section approximated based on Museum Island Station (see above)

MI-3
(D. Reda - GZ)
Alt. Concept to large SEM Cavern for X-Over (above example from TYSSE X-Over Cavern)
- Reduced excavation
- Reduced Materials
- Reduced risk

MI-4
(D. Reda - GZ)
During the workshop, it was brought up that side platforms would help reduce the overall length of the SEM X-Over
- to be checked, but a shorter X-Over cavern may force the TBM Retrieval in the main Station Box (e.g. no logical location for separate retrieval shaft)

MI-5
(D. Reda - GZ)
Alt. Concept for Pipe Box is also possible
- Reduced excavation
- Reduced Materials
- Reduced risk
- Groundwater Control

MI-6
Reduce track centers to reduce the size of the cross-over cavern. Use side platform station for PSQ.

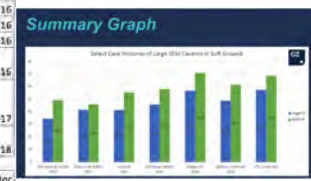
MI-7
East Link Bellevue Main St Station:
Side Platform

Untitled | 0

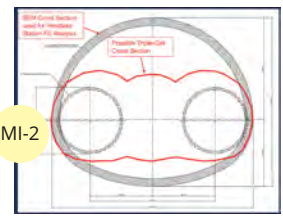
MI-1

Approx. Dates for Benchmarking SEM	
Crosscut Pipe Arch (start)	Feb-16
Crosscut Pipe Arch (end)	Apr-16
Crosscut Exc (start)	May-16
Crosscut Exc (end)	Nov-16
Cavern Pipe Arch (start)	Nov-16
Cavern Pipe Arch (end)	Nov-16
(2 directions (300-ft total)	Cavern Exc (start)	Nov-16
(2 directions (300-ft total)	Cavern Exc (end) (unconfirmed split with crossover cavern)	Oct-17
(Crossover is 265-ft)	Completed Cavern & Crossover Exc	May-18

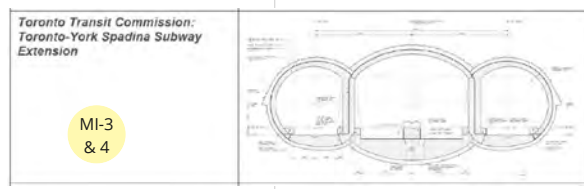
Chinatown Station ~2,060 sf	Factor
WSBLE Station Cavern ~3,115 sf	1.51



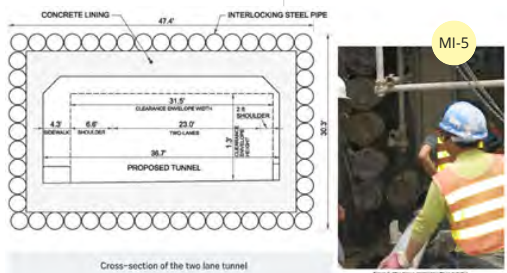
MI-2



MI-3 & 4

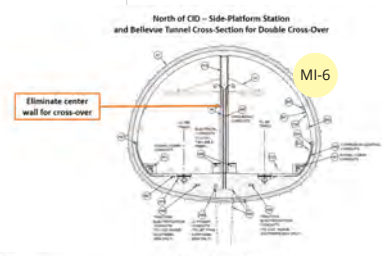


MI-5



Cross-section of the two lane tunnel

MI-6



MI-7

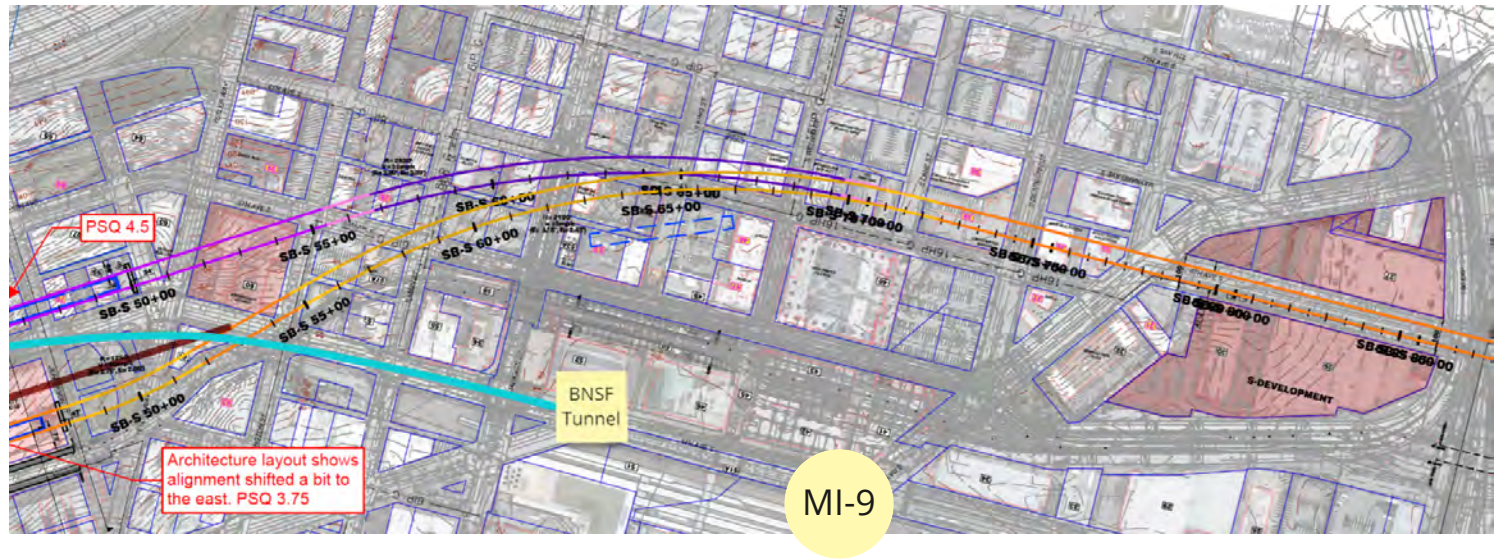


Mitigate Impacts | 3

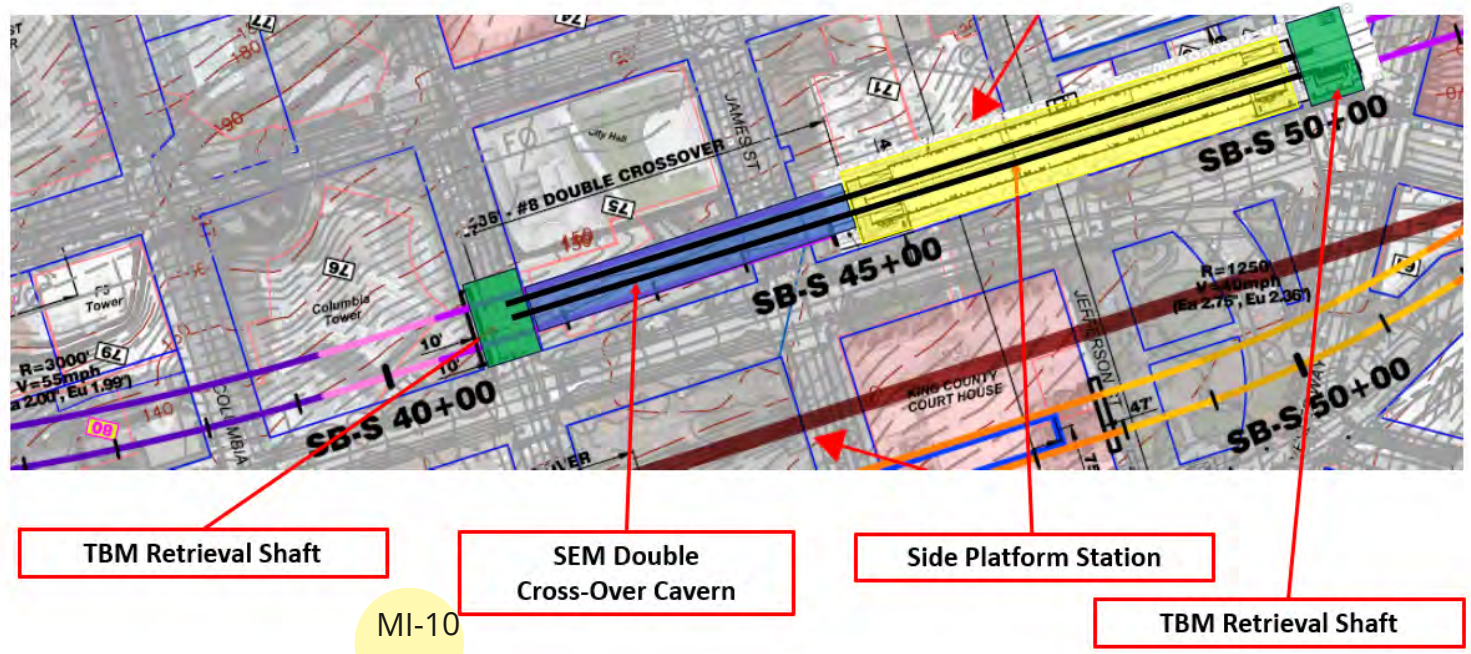
MI-8
Eliminate center wall for cross-over

MI-9
Can the crossover be moved to CID south and be constructed in a larger Cut and Cover?

MI-10
Use side platform for North of CID Station and reduce SEM cavern cross-over size to that of Bellevue SEM Tunnel



North of CID – Side-Platform Station
and Bellevue Tunnel Cross-Section for Double Cross-Over



Miscellaneous Ideas | 1

M-1
Keep alignment tangent at SoCID station. Minimize reversing curves and width through area. Less surface impact west of 6th.

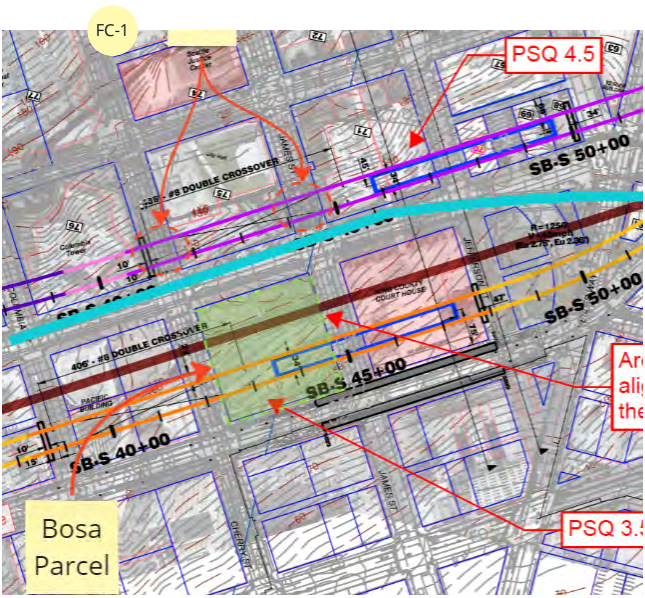
Facilitate Construction | 3

FC-1
Explore alternatives to Cherry St Shaft location

FC-2
Move CID North South about 75' to under Terrace St to reduce the amount of SEM Crossover tunnel. This area under Terrace St could be in the basement of the Yesler Building

FC-3
Can a tenant improvement in the basement of the King County Courthouse be done for a ped tunnel to Pioneer Sq Station





SCHEDULE ANALYSIS PROCESS

SCHEDULE ANALYSIS PROCESS

A systematic approach was used for the Schedule Analysis Workshop. The key procedures followed were organized into three distinct parts: (1) Pre-Workshop Preparation, (2) SA Workshop, and (3) Post-Workshop Procedures.

PRE-WORKSHOP PREPARATION

In preparation for the SA study, the SA team reviewed the documents provided by the designer to become better prepared for the study. The following activities were conducted prior to the SA study:

- An in-person kick-off meeting and site visit was conducted on Friday, August 11th at the offices of Sound Transit. The SA team toured the key alignment station and excavation locations.
- Each team member prepared a Key Issues Memo (KIM) which documented their review of the project documents prior to the workshop. The KIM included the team member's observations, issues, challenges, and opportunities related to the project. The KIMs were submitted to the Sound Transit Project Team prior to the commencement of the SA workshop.

SA WORKSHOP

The SA workshop followed a specific process that guided the team in the consideration of project functionality and performance, potential schedule issues, high-cost areas, and risk factors in the design. These considerations are taken into account in developing alternative solutions for the optimization of project value. The process phases are:

- Information Phase
- Function Analysis Phase
- Creativity Phase
- Evaluation Phase
- Development Phase
- Presentation Phase

The SA workshop was conducted virtually using MS Teams and the Miro® collaborative whiteboard application.

Information Phase

At the beginning of the SA workshop, the project team presents a more detailed review of the project alignment alternatives and their supporting schedules. This includes an overview of the project and its various requirements which further enhances the SA team's knowledge and understanding of the project. The project team also responds to questions posed by the SA team.

Function Analysis Phase

Key to the SA process is the function analysis techniques used during the Function Analysis Phase. Analyzing the functional requirements of a project is essential to assure an owner that the project has been designed to meet the stated criteria and its need and purpose. The analysis of these functions in terms of cost, performance, time, and risk is a primary element in an SA workshop and is used to develop options. This procedure is beneficial to the SA team, as it forces the participants to think in terms of functions and their relative value in meeting the project's need and purpose. This facilitates a deeper understanding of the project.

Creativity Phase

The Creativity Phase involves identifying and listing creative ideas. During this phase, the SA team participates in a brainstorming session to identify as many means as possible to provide the necessary project functions. The judgment of the ideas is not permitted in order to generate a broad range of ideas.

The idea list includes all of the ideas suggested during the study. These ideas should be reviewed further by the project team, since they may contain ideas that are worthy of further evaluation and may be used as the design develops. These ideas could also help stimulate additional ideas by others.

Both individual and group brainstorming techniques were applied resulting in the identification of 62 ideas.

Evaluation Phase

The purpose of the Evaluation Phase is to systematically assess the potential impacts of ideas generated during the Creativity Phase relative to their potential for value improvement. Each idea is evaluated in terms of its potential impact to performance, cost, schedule, and risk. Once each idea is fully evaluated, it is dismissed or moved forward for development.

A mid-point review was conducted following the SA team's evaluation session. During this meeting, the SA team discussed the various top-rated ideas with the project team. Feedback was subsequently incorporated into the development of the SA options.

Development Phase

During the Development Phase, the highly rated ideas are expanded and developed into SA options. The development process considers the impact to performance, cost, time, and risk of the alternative concepts relative to the baseline concept. This analysis is prepared as appropriate for each alternative, and the information may include a performance assessment, initial cost, and life cycle cost comparisons, schedule analysis, and an assessment of risk. Each alternative describes the baseline concept and proposed changes and includes a technical discussion. Sketches and calculations are also prepared for each alternative as appropriate.

Presentation Phase

The SA workshop concludes with a preliminary presentation of the SA team's assessment of the project and SA options. The presentation provides an opportunity for the owner, project team, and stakeholders to preview the options and develop an understanding of the rationale behind them.

POST-WORKSHOP PROCEDURES

A *Preliminary Schedule Analysis Workshop Report* is prepared after the completion of the workshop. This report summarizes the activities and results of the SA workshop. Once this report has been reviewed by the owner and project team, an implementation meeting is held in order to determine the disposition of the options presented therein. An implementation plan is developed for those accepted SA Options which details actions, responsibilities, and key milestones for integrating them into the project. SA Options that are rejected include a summary of the reasons for their rejection. A *Final Schedule Analysis Workshop Report* is prepared once the implementation results are finalized.

SCHEDULE ANALYSIS WORKSHOP ATTENDEES

8/14	8/15	8/16	8/17	8/18	Name	Organization	Position/Role	E-mail
X	X	X		X	Anthony Pooley	Sound Transit	Principal Construction Manager	anthony.pooley@soundtransit.org
X					Artur Kasperski	HNTB Corporation	National Tunnel Practice at HNTB	akasperski@hntb.com
X	X	X	X	X	Bill James	HNTB Corporation	MOT/Traffic	wjames@hntb.com
X	X		X	X	Cody Reiter	Sound Transit	Government & Community Relations	cody.reiter@soundtransit.org
		X		X	Daniel Turner	Sound Transit	Transportation Planner and Project Manager	daniel.turner@soundtransit.org
		X		X	David Shelton	Sound Transit	Deputy Project Manager	c-david.dhelton@soundtransit.org
X	X	X	X	X	Dick Sage	Independent Consultant	Heavy Construction	c-richard.dage@soundtransit.org
		X		X	Dirk Bakker	Sound Transit	Corridor Design Manager	dirk.bakker@soundtransit.org
X	X	X	X	X	Dominic Reda	Gall Zeidler Consultants	Tunneling	dreda@gzconsultants1.onmicrosoft.com
X				X	Forrest Dill	Ott-Sakai & Associates, LLC	Senior Construction Consultant	forrest@ott-sakai.com
X	X				Guan, Hong	Jacobs Engineering Group, Inc.	Senior Technologist	hong.guan@jacobs.com
X	X				Jake Stephens	Sound Transit	Project Controls Intern	jake.stevens@soundtransit.org

8/14	8/15	8/16	8/17	8/18	Name	Organization	Position/Role	E-mail
				X	James Parsons	HNTB Corporation	Director of National Transit Programs and Vice President at HNTB	jdparsons@hntb.com
X	X	X	X	X	James Wonneberg	HNTB Corporation	Scheduling	jwonneberg@hntb.com
X	X				Jeff Schutt	Jacobs Engineering Group, Inc.	Director of Engineering	jeff.schutt@jacobs.com
X	X	X	X	X	Kelly Burnell	Kleinfelder, Inc.	Bridge	kburnell@kleinfelder.com
X		X		X	Kim Proia	HNTB Corporation	Project Director	c-kim.proia@soundtransit.org
		X		X	Leda Chahim	Sound Transit	Central Corridor Director, Govt. & Community Relations	leda.chahim@soundtransit.org
X	X	X	X	X	Matt Matsumoto	KBA, Inc.	Heavy Construction	mmatsumoto@kbacm.com
X					Paul Anthony Gasson	Jacobs Engineering Group, Inc.	Program Manager	paul.gasson@jacobs.com
X					Per Vilhelmsson	HNTB Corporation	Construction Lead Technical Advisor, Program Manager	pvilhelmsson@hntb.com
X	X	X		X	Rahul Nagalkar	Sound Transit	Deputy Director of Value Engineering	rahul.nagalkar@soundtransit.org
x	X	X	X	X	Red Robinson	Shannon & Wilson	Geotechnical	red.robinson@shanwil.com
X	X	X	X	X	Richard Raine	Independent Consultant	Heavy Construction	richardhraine@gmail.com
X	X			X	Ron Endlich	Sound Transit	Deputy Project Director	ron.endlich@soundtransit.org

8/14	8/15	8/16	8/17	8/18	Name	Organization	Position/Role	E-mail
X		X		X	Salima Hamlin	HNTB Corporation	Senior Project Manager	shamlin@hntb.com
		X		X	Sandra Fann	Sound Transit	Central Corridor HCT Project Director	sandra.fann@soundtransit.org
X				X	Stephen Mak	Sound Transit	High-Capacity Transit Development Manager	stephen.mak@soundtransit.org
X	X	X	X	X	CJ Bevins	VMS, Inc.	Technical Editor, Assistant Workshop Facilitator	cj.bevins@vms-inc.com
X	X	X	X	X	Robert Stewart	VMS, Inc.	President, CEO, Workshop Facilitator	rob@vms-inc.com

APPENDIX - A

August 8, 2023

Rahul Nagalkar, CVS
Deputy Director - Value Engineering
Portfolio Services Office (PSO)
Sound Transit

RE: WSBLE 4th Ave. Shallow Option – Key Issues Memo (KIM)

The Dave Peters Optimization Strategy presentation details 5 potential alternative case studies to construct the 4th Ave. Shallow Option. The following general observations were made:

- Were schedules of any kind developed for any of the five case studies?
- Does ST want the Workshop Team to further evaluate these case studies? Have any been outright rejected at this point?
- Has a Risk Register been developed for the 4th Ave. Shallow Option?

This content was reviewed and the following issues are raised:

- **Case 1 - Top-Down Construction with New Viaduct**
    - Is there sufficient clearance to construct SPTC slurry walls under the West half of the existing viaduct?
    - Is the existing condition of the viaduct superstructure sufficient to withstand this modification?
    - Assumption is that this approach only saves 1-year by eliminating temporary structure. No other schedule benefits?
- **Case 2 - Top-Down Construction with Existing Viaduct**
    - Is there sufficient clearance to construct SPTC slurry walls under the West half of the existing viaduct? Seems like there is even less clearance than Case 1.
    - Is the existing condition of the viaduct superstructure sufficient to withstand this modification? Now we are placing the entire existing viaduct structure on a new permanent foundation.
    - This eliminates temporary construction needed to support viaduct – how much time would this save (not stated).

- It is stated that 3+ years are added to the schedule due to reduced clearance to perform cut and cover station construction (i.e., assumes reduction in productivity). Could this challenge be mitigated by developing improved, temporary construction access at south portal?

- **Case 3 - Retained Cut with Viaduct Canopy**
  - This option sounds like something similar in configuration to the existing CID station ("open air"). Basically Case 1 without a lid.
  - Unclear what the schedule benefits are. Assume it would save more time then Case 1.

- **Case 4 - Station & Track At-Grade**
  - It is unclear how much time this could save, but it seems like it could be significant.
  - What is ST's position on inter-station circulation? Is this case study a "no-go?"
  - The "challenges" identified do not seem insurmountable.
  - It is unclear to me what the tunneling implications are without seeing the profile.

- **Case 5 - Optimize Profile**
  - The grades are steeper in this option (from max of 4% up to 7%) – can ST Operations live with this?
  - Greater risks related to DSTT.
  - Statement is made that this option was discarded due to additional property takes. Is this a "show stopper?"
  - There is no statement made about potential schedule savings. Was this discussed?

VALUE MANAGEMENT STRATEGIES, INC.

Robert B. Stewart, CVS-Life, FSAVE, PMP, PMI-RMP
President / CEO

SOUND TRANSIT
4TH AVENUE SHALLOW OPTION KEY ISSUES MEMO

TO: Robert Stewart

FROM: Richard Raine

DATE: 08/06/2023

REF: Sound Transit 4th Avenue Shallow Option

Rob,

Per your request here is my Key Issues Memo for the above referenced project. It is based on initial review of preliminary documents regarding the project. My understanding of the upcoming workshop is as follows:

- Validate current assumptions for the 4th Avenue Shallow Option schedule.
- Identify new ideas and concepts that could reduce the current construction duration for the 4th Avenue Shallow Option schedule (target is 6-7 years).
- Validate the overall constructability and activity durations of the North and South of CID Alignment

Phased project and very long schedule

The draft schedule provided is very long (12 years) (April 2025 to March 2037). Very long, phased projects are risky as they are hard to predict are susceptible to disruption due to unforeseen events such as geotechnical issues, utilities, logistical issues etc. This type of project is also hard to accelerate or recover from schedule slippage due to the congested nature of the site and the phased nature of construction. Having said that, ST should identify the major risks to the project (related to schedule) and develop contingencies to address them. Project delays are among the mostly significant cost drivers on a project.

High risk and potentially limited bidders

I could not find a project cost estimate but for a project like this it is likely a high number. High cost combined with a long schedule and high-risk type of work will limit the bidding pool and drive up bids. In my experience contractors have become much more risk averse on very large hard money projects and that will likely be the case here. Additionally, it is likely that the large contractors will form joint ventures to bid this job which will further limit the number of bidders

and put upward pressure of prices. Sound Transit should reach out to the contracting community to gage their interest in the job and hold meetings with potential bidders to develop reasonable contract terms for both parties. Alternatively Sound Transit might consider alternative contracting models such as progressive design build or alliance contracting with the best qualified team. All models have pros and cons.

Consider schedule drivers in project development.

The plans and concepts I have seen so far are very preliminary so it is difficult to estimate cost or schedule. Some key drivers of schedule are:

- Quantities
- Opportunity to work multiple headings at same time
- Influence of stakeholders during construction
- Logistical burdens such as work hours, regulatory requirements, staging, haul routes, waste sites etc.
- Phasing
- Long lead time items (such as steel)
- Utilities
- ROW acquisition
- Unforeseen circumstances such as geotechnical issues.
- Traffic interface and flow requirements

Sound Transit is already working to address some of these. The goal should be to try to set the contractor up for success, and not just dump as much risk on the contractor as possible.

Sound Transit should keep these drivers in mind as they develop the project and work to minimize the effects of each one. The project is phased which means one phase needs to be completed before the next one can begin (and then all the activities are repeated). The phasing tends to extend project schedule and it also tends to limit the contractor's ability to recover schedule slippage.

The documents I reviewed indicated the contractor's work hours would be limited. I understand some limitation on work hours is needed but, as much as possible the contractor should be given maximum flexibility to execute the project. This will allow him to respond much better to changes and delays.

BNSF

In my experience working near a railroad can cause major schedule problems This can come in the form of lengthy submittal reviews, rigid limitations on settlement or adjacent construction activities, or interference during construction. To the maximum extent possible Sound Transit should try to work through all of BNSF restrictions before the project is solicited and reasonable

workable solutions should be adopted which have high probability of success. All parties must clearly understand the BNSF requirements from the beginning. If possible, Sound Transit may consider negotiating with BNSF for them to assign a full-time responsible person to this project (at ST's expense) to help expedite and stream line communication and approvals. Developing and maintaining a good working relationship with the BNSF will be important to advance the project and avoid delays.

Consideration of logistics in project development

This project will require a lot of workers, equipment and materials to move in and out from the congested site on a constant basis. There will be thousands of truck loads. The contractor needs sufficient lay down and working areas to do the work and he needs good roadway access to feed the work. Whatever Sound Transit can do to facilitate these logistics will help the contractor to perform better and reduce schedule risk.

The contractor will need to utilize lights for night work and the equipment and the nature of the work is noisy. I understand there has to be some restrictions on these things but as much as Sound Transit can facilitate this with adjacent stakeholders the better. Too many limitations of this kind can severely limit productivity.

Dewatering is likely to be significant and a workable plan to handle water should be developed. It is important that the plan be as practical as possible and limit the amount t of physical space required for plant and equipment of this type. Sound Transit should ensure a workable dewatering and water handling plan is included in the environmental document.

All parties should be flexible in how they administer the project to allow the contractor to adjust to events as they unfold. The more rigid the requirements and administration of them, the more difficult it is to maintain schedule and recover from unforeseen delays.

ROM Scheduling

There are a number of examples of underground stations built in urban environments around the country such as Los Angeles Boston and Chicago. Sound Transit should consider collecting the schedule data from these projects (and maybe it already has) to help establish a rough order of magnitude of the time it will take to construct this project. Understanding size, phasing and logistical constraints of these other projects is necessary to perform a more accurate analysis, and it is best to use as-built information.

Discipline integration

In my experience with underground stations the integration of disciplines is an important aspect of design and construction. This means understanding the full scope of electrical, systems, FLS, HVAC, rebar and concrete early and designing the work in an integrated way so there is enough room to accommodate all disciplines. Additionally, having good separation

between disciplines is highly desirable. This will prevent issues and delays in the field due to conflicts between the trades and physical conflicts between the elements.

Physical space limitations on schedule

Until I have a better understanding of the job, I am not able to provide specific comments on the draft schedule provided. However, the schedule contemplates multiple operations occurring at the same time. Given the tight space constraints a time-space review of the assumptions in the schedule should be performed to ensure they are reasonable.

I will continue to review the documents in the lead up to the site visit and workshop. If you have any questions, please don't hesitate to contact me.

Key Issue Memorandum

To: Rob Stewart, VMS

From: Kelly Burnell, Kleinfelder

Date: 8/7/23

Project: Sound Transit: 4th Avenue Shallow Station and North and South CID Alignments

Based on my initial review of the project documents provided, the following are issues, opportunities, and questions that I have related to the project.

Traffic Detours and Closures

Maintenance of vehicle traffic through this area is the major driver for the complicated staging operations in place. 4th Ave is the major N-S surface route connection. The new patterns that emerge during this project will become well established and accepted after a short period relative to the overall construction timeframe.

Given the length of time this project will be on-going, even if improvements to the schedule are made, can offline improvements to adjacent parallel routes that will see increased traffic such as 1st Ave and 5th Ave be made permanent or expanded from the current configuration? Were improved connections to the Alaskan Way Viaduct considered to allow an improved movement to that structure?

Several of the E-W connections across 4th are also to be closed for extended periods of time such as Jackson, Main, and Seattle Blvd. Can any of these closures be made permanent given the length of time they are being shut down for this project? Or could some of these intersections be reconfigured to provide improvements, such as shifting the connection of 2nd Ave to 4th Ave north to improve or coincide with the intersection with Jackson.

It is unclear if any accommodations from BNSF have been pursued. Given their proximity and the issues typical of working adjacent to an active rail, discussions with them to relax or adjust some of their standard requirements may be beneficial to the project.

Structural Issues

The viaduct is proposed to be replaced in stages with a temporary viaduct, then the station built under, followed by the construction of the permanent viaduct. Given the driving traffic concerns, can the permanent viaduct be constructed first to allow full traffic back on top while construction commences below? What considerations led to a full width temporary structure?

The variety in age and composition of structures through this corridor adds another level of complexity to the project. The baseline concept of providing an all-new Viaduct structure atop the CID station will simplify the project overall. The viaduct layout, in particular the support locations, should be carefully considered to provide maximum flexibility for future configuration changes or modifications for

additional future projects. Stacking modes of transportation vertically makes for complex replacement down the road.

Some concepts proposed looked at reuse of portions of the existing viaduct. This mixing of an old structure atop a new foundation may be a savings at this time, but the condition and expected remaining lifespan of the superstructure need to be carefully considered. If the structure is of a type and condition that can be maintained long term, then it may be an advantage. However, it may also tie the hands of future projects or require an additional project in the near future to replace the old portion.

North and South of CID Alternatives

The level of detail available for these alternatives currently makes a comparison between the baseline project and these alternatives difficult. If one of the primary objectives is to provide a link between the new line and the existing transit lines, then the baseline option provides the most coherent long-term link to the widest number of transit options in the area and acts as the most like a central transfer station. Reducing the connectivity between modes to save schedule for a project of this magnitude and duration would need to be carefully considered.

The North of CID alternative provides the second-best connectivity and is in the central core of downtown which provides good access to businesses. This alternative does place the station in a very constrained space for construction as well. Making construction difficult and risky given the surrounding structures.

The South of CID alternative does not provide good connectivity between the light rail lines, to the heavy rail corridor, or to a major employment center. It is unclear what the advantage of this location is from a utility standpoint. It is easier to construct.

Schedule Considerations and Activities

The baseline schedule of 12 years for the CID Station is a major risk given the possibilities for change in need, political climate, or other factors that are difficult to foresee. Similar long-term projects such as the Big Dig or CA High Speed Rail have had significant challenges. For this reason, any options to reduce schedule even if it comes with higher sticker price or more invasive methods for the community should be pursued.

While additional in-depth study of the schedule assumptions will occur, there should be opportunities to maximize productivity through some of the following methods:

- Multiple contracts or other methods to bring in multiple contractors and increase the number of shifts/rigs available.
- Contractor incentives/disincentives for productivity or schedule targets.
- Use of precast/prefabricated or steel members to minimize required forming/cure times.
- Expand full closures or put more closures to occur concurrently to increase productivity for key activities.

Additionally, sufficient contingency for activities within the ground needs to be considered. Risks such as contamination, utilities, cultural discoveries, or geologic changes can halt construction and add significant risk. Are there opportunities to mitigate early or have mitigation plans agreed to early on with the impacted parties?

Key Issues Memo

To: Robert Stewart, VMS
From: James Wonneberg, HNTB
Date: 8/5/23

Subject: **WSBLE 4th Ave/CID Station – Shallow Concept – Schedule Workshop**

Enclosure: *WSBLE 4th Ave CID Station Shallow_Summary Schedule_DRAFT rev 0.pdf*

Rob,

I have reviewed the reference materials provided, including the Microsoft Project schedule dated 11-21-22 ("MPP schedule").

I then used GraphicSchedule to summarize the contents of the MPP schedule on a 1-page bar chart. Please see attached.

I took the liberty of adding staging and phasing nomenclature, because I think it will help make it easier for everyone to talk about the scope of work and schedule during the workshop. If this is not desired, or if the staging/phasing needs to be revised, I am happy to make changes as needed.

Based on this initial review, I have the following questions:

1. Who is the author of the MPP schedule? Will they be available during the workshop?
2. Are conceptual design drawings available for this work?
3. Activity 41 in the MPP schedule refers to "Goodwill Area". Should this be "Salvation Army"?
4. The MPP schedule uses a variety of terms such as "Permanent Lid Structure", "Permanent Viaduct", and "New Viaduct". Do these terms all basically mean the same thing i.e. constructing a new 4th Ave Viaduct?
5. The reference document *EWG 75 4th Shallow Construction Staging Concept 20220107* shows a temporary steel road deck from Seattle Blvd to Jackson. No temporary decking activities are found in the MPP schedule. Only permanent viaduct construction activities are scheduled. Please confirm that the temporary decking staging concept is not used.
6. Could the project timeline be shortened by consolidating Stage 1 and Stage 2 into a single stage from Jackson to I-90?
    a. Stage 1/Phase 1 concurrent with Stage 2/Phase 1 (East Side of 4th)
    b. Stage 1/Phase 2 concurrent with Stage 2/Phase 2 (West Side of 4th)
7. Will Main St be closed twice? Once for the duration of Stage 3, and again during the Main St Bridge replacement in Stage 5?
8. What is the purpose of MPP activities 16 & 17? (4th Ave from Main to Washington) Is there a separate closure from Main to Washington that we need to be aware of?
9. MPP activity 25 & 26 are duplicates of MPP activities 13 & 14. Consider deleting these activities and associated logic, to avoid errors and confusion.

10. The MPP activities listed below currently have zero duration, presumably because they are placeholders for further study. These activities may need to be evaluated and assigned a duration to determine the schedule impacts to road closures and project timelines:

    4th Ave from Main to Yesler (SEM Portal):

    112 Excavate to BNSF Track Grade (above the water table) (800' x 58' x 6')
    113 Jet Grout the Seal (800' x 58' x 20') @ 200 cy per rig per shift - 2 rigs
    115 Dewater to Subgrade (40' avg x 58' x 800')
    117 Mudslab Over Jet Grout Seal (6' x 58' x 800')
    118 Track Slab, Walls, and Roof incl Cure
    122 Backfill West Side to BNSF Track Elevation (10' x 16' x 800')
    123 BNSF Fence

    Systems and Commissioning:

    167 Systems (not included)

[end]

August 7, 2023

Robert Stewart
Value Management Strategies, Inc
100 E San Marcos Blvd, Suite 340
San Marcos, CA 92069

Re: Sound Transit 4th Ave Shallow Option
Key Issues Memorandum

Dear Robert:

After a brief review of the project documents provided by Sound Transit on 7/27/23 please find below my key issues memo:

- BNSF and Amtrak Coordination
- Night Time Noise Variance
- Utility Relocation – 30 Days (6 weeks). Confirm amount of utility relocates. The documents provided indicate at least a 12" water and 48" combined sewer
- Maintenance of Traffic
    - Weller St Pedestrian Bridge – Access during construction?
    - 2 Lane 4th Ave S – Southbound only
    - Sidewalks open or closed?
- Slurry Wall Construction
    - Anticipated location of slurry plant. Will the slurry lines need to cross under the railroad.
        - Enough area needs to be provided to support 2 slurry wall operation be schedule.
    - Slurry Wall Method – Hydromill or clam shelling?
        - Clam shelling will require trucking access.
    - Job Site width – Ensure width of site is adequate for both slurry wall excavation equipment and support crane.
        - Specifically West Wall
    - Wall Depth – Adequate room needs to be provided to fabricate solider piles
    - Schedule 10 LF per Rig per Day – Assume 10 LF equals 1 panel pour per day.
    - Walls will need to be constructed from North to South due to the
    - 2 Rig plan – Is there enough space for 2 concurrent excavations including support equipment.
        - Access to the north could be limited by installation of temp steel columns in slurry wall
    - Support crane size to be determined by size and depth of piles.
    - Confirm soil conditions to construct slurry walls adjacent to live railroad.
- Box Construction
    - Slurry Walls to be used a permanent structural walls.

- Waterproofing will need to be addressed
    - Refer to Husky Stadium Station Design
- TBM Retrial Date
    - Check date vs construction of North Box (S Main to S Jackson)

Please let me know if you have any questions.

Sincerely,
KBA, Inc.

Matthew Matsumoto

Matt Matsumoto
Construction Manager

HNTB Corporation
The HNTB Companies
Engineers Architects Planners

700-108th Ave NE
Suite 1000
Bellevue, WA 98004

Telephone (425) 455-3555
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Memorandum

HNTB

Date August 6, 2023

To Robert Stewart

From Bill James

Subject Key Issues Memorandum – Traffic
Construction Schedule Analysis Workshop
4th Ave. Shallow Option / North & South of CID Alignment

This key issues memorandum provides observations and questions related to traffic issues, including traffic control and maintenance of traffic (MOT), during construction of station options serving the Chinatown / International District (CID), and associated LRT guideway alignments. These options include a 4th Avenue shallow station and stations north and south of the CID that are currently under consideration by Sound Transit's West Seattle to Ballard Link Light Rail extensions project. I have reviewed the materials provided in advance of the upcoming workshop, including public workshop presentations, the CID Further Study Report, guideway alignment/profile and station roll maps, conceptual architectural layouts, construction staging concept typical sections, and construction schedule summaries.

Maintenance of Traffic

Please clarify the anticipated number and direction of open traffic lanes on 4th Avenue during construction of the 4th Avenue shallow station option. Some of the public materials reference one lane open in each direction, but the construction schedule and typical sections reference two southbound lanes open. The latter would appear to facilitate keeping the southbound connection from 2nd Avenue open to the maximum extent possible, which would be advisable given that of 2nd Avenue provides access to regional routes from the downtown street grid.

To what extent are the origins and destinations of traffic using 4th Avenue through the affected project area known? In particular, what is the magnitude of vehicle trips passing through the area versus trips with origins or destinations local to the CID and Pioneer Square areas? The particular mix of through versus locally-oriented trips could influence the traffic control strategy and associated mitigation measures that might be considered.

Is the intent for 5th Avenue to be a bus-only corridor during construction? Would it also be anticipated to provide a detour route for northbound 4th Avenue general traffic if 4th Avenue is one-way southbound during construction of the shallow option station?

To what extent will existing transit bus routes impacted by project construction activities be affected by upcoming service realignments associated with the opening of the East Link, Lynnwood Link and Federal Way Link extensions? Will the number of transit bus routes passing through the project area be reduced?

An I-5 collector-distributor (C-D) roadway contraflow lane as a detour route is referenced in some of the documents. Where is this and which traffic movements would this serve?

Has the potential impact on travel patterns of other regional projects that might overlap the 4th Avenue closures been considered? Two examples include SR 520 corridor reconstruction

projects (2024 to 2030), which could shift traffic to the I-90 corridor, and reconstruction of I-5 north of the Ship Canal Bridge (2027 to 2029), which could shift traffic to the SR 99 corridor.

Construction Schedule

Daytime-only work is referenced in several documents, due to noise variance and other considerations including worker fatigue related to extended durations of 24/7 construction operations. Given the magnitude of impacts to mobility resulting from 4th Avenue and cross-street closures, this assumption should be revisited for at least some elements of work. Two shifts of work should be feasible for work not in proximity to residences or other sensitive noise receptors. To use one example, based on the typical sections provided, tunnel excavation work for the 4th Avenue shallow option would largely be shielded from adjacent sensitive receptors by the adjacent or overhead viaduct structure and adjacent buildings, particularly for the portion of work between the I-90 ramps and South Jackson Street. I also note that hauling operations are commonly restricted to off-peak hours, including evening and overnight hours.

Why is the work on 4th Avenue south of South Jackson Street to I-90 shown in consecutive rather than concurrent closures? The provided construction schedule indicates a two-year restriction on 4th Avenue from the I-90 ramps north to Seattle Boulevard, followed by a four-year restriction on 4th Avenue from Seattle Boulevard north to S. Jackson Street.

To what degree has the team considered the potential impact of Design-Bid-Build versus Design-Build project delivery on the construction schedule? Design-Build could be more suitable to providing incentives to the contractor to reduce the duration of the construction schedule and minimizing impacts to mobility and adjacent neighborhoods during construction.

cc: project file 77676-PL-008

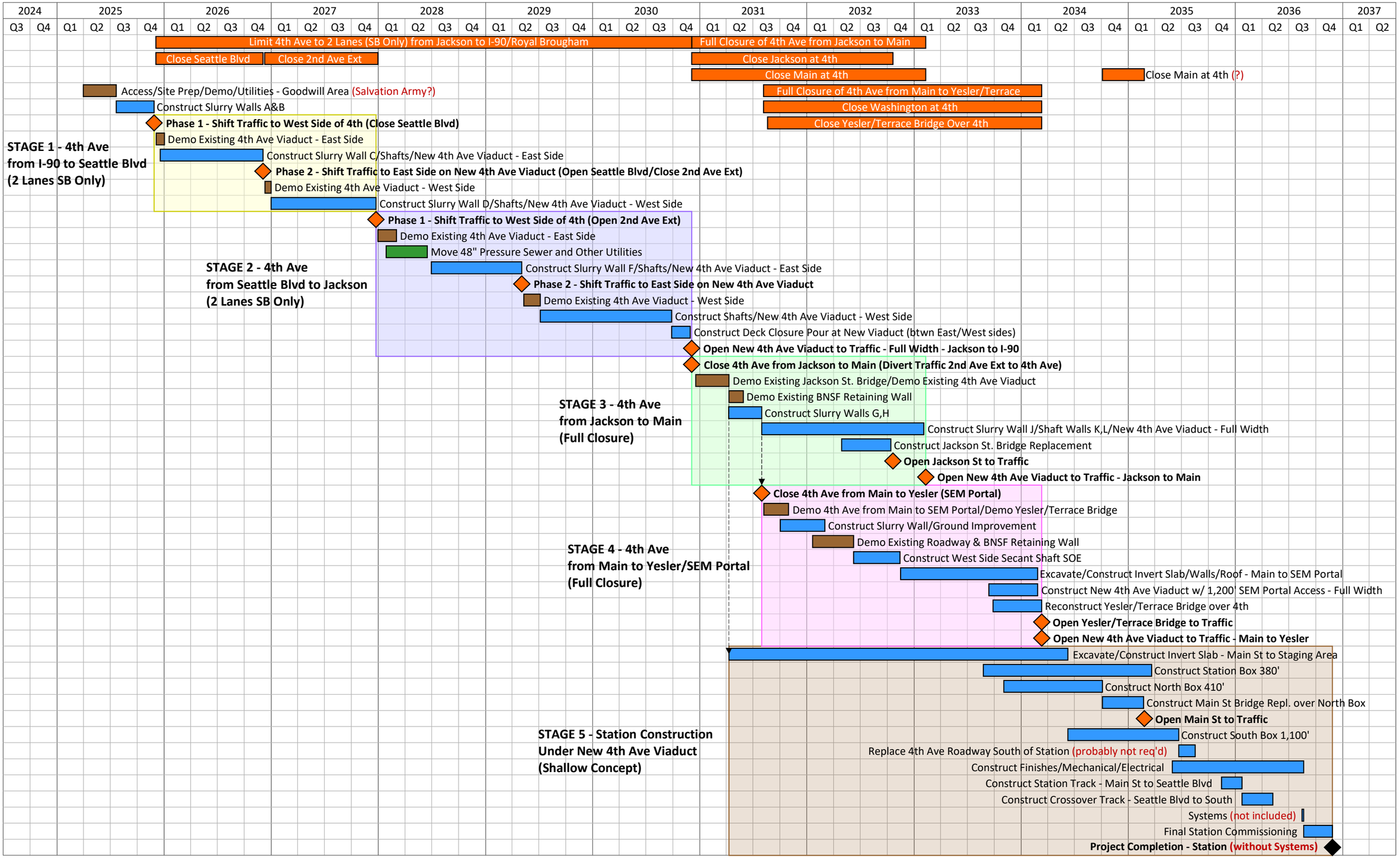
WSBLE 4th Ave CID Station - Shallow Concept - Summary Schedule

Activities and durations based on MPP schedule dated 11-21-22

Staging and phasing added by JRW (DRAFT)

DRAFT rev 0

JRW 5-Aug-23



GraphicSchedule.com

KEY ISSUE MEMORANDUM

TO: Robert Stewart

FROM: Richard Sage

DATE: 07/30/2023

REF: ST WSBLE – 4th Ave Options - VE Workshop

Rob,

Here is my Key Issues Memo (KIM) for the Sound Transit WSBLE – 4th Ave Options (Schedule Analysis) VE Workshop. My observations and comments in this memo are based on the conceptual plans, construction staging sequence drawings, the PPT presentation "CID Dave Peters Comments" and the schedules that were provided for our review. If you have questions or comments, please let me know.

Additional information that would be beneficial:

- East Link Bellevue Tunnel SEM After-Action Report.
- Construction Staging Sequence - Sheets #1, #5 and #9 through #12 (missing from document provided).
- Traffic Analysis (4th Ave south of S. Jackson St.) – vehicle count by cars, buses and trucks, by day of week and by hour of day.
- Printed Roll maps of:
    - CID 4th Ave Shallow Downtown – SODO
    - 4th Shallow CID w / Mez over DSTT & 1200' SEM Tunnel to North to Midtown Station.

Construction Staging Sequence

Sheets #1, #5 and #9 through #12 are missing.

The drawings show:

- Installation of temporary steel column in the slurry wall to support the temporary roadway.
    - Has that been done previously?
    - There might be issues with
        - Support of the column until the concrete cures
        - Maintaining proper alignment / elevation until the concrete cures
- Sheet 2 shows maintaining 2 lanes of SB traffic on 4th Ave. What happened to the NB traffic?
- How will access to the underground parking be maintained for both the commercial and Sound Transit parking lots.
- This area probably contains old trestles and pier piles. The Nisqually earthquake in 2003 exposed the location of many pre-existing piles on the west side of 4th Ave in the parking lot.
- Removal of the existing overhang on the west will conflict with the "Min RR Construction Clearance Envelop" by 6'.
- The groundwater elevation is at approx. Elev. 10', the top of non-liquifiable material is at approx. elevation -35' to -90'. Sheet 4 shows a temporary steel pile that doesn't fully penetrate the

liquefiable zone. This could be a problem if an earthquake occurs during this phase of construction.

- Sheet 5 shows the installation of shoring for the removal of the existing footings and guide walls. This shoring conflicts with the "Min RR Construction Clearance Envelop".
- Assure that the prestress concrete deck is designed adequately for construction (crane) loadings, not just highway loadings. This was not done at the LACMTA North Hollywood Station and caused a lot of problems and needlessly cost the contractor / owner a lot of money.
- The drawings show an asphalt topcoat over the PS concrete panels. Provide a removable section of decking for materials access through the deck during construction below the roadway deck.
- How is the access to the King St. Station provided from the east side of 4th Ave.
- Is the Pedestrian bridge over the BSNF RR tracks to be maintained or replaced. If maintained, how will the passengers access the ped bridge prior to the temporary roadway deck being completed on the west side of 4th.
- Sheet 6 – During demolition of the eastern portion of the viaduct, how is the existing CMU wall at Union Station going to be protected from damage.
- What is the access to the east side of 4th from the west side during demolition and construction on the east side of 4th Ave.
- What / Where is the access for excavation equipment, muck removal and delivery of wales and struts.
- There is a potential to "tube-block" the operations while installing wales and structs. Assure that there is access for concurrent excavation and wale/struct installation or reflect this constraint in the schedule.
- Assure that the wale / struct vertical spacing and locations will allow for the wall and floor slab to be poured without having to re-shore the slurry wall to place the floor slab. The wales and struts should be adequately sized to be located about 3 feet above each deck pour, without intermediate wales and struts.
- What is the vertical spacing of the wales / struct? Confirm that there is sufficient vertical room for excavation equipment access (dozers, loaders, trucks) and trucks and cranes for deliver and placement of wales & struts, as the decking as currently designed (with AC overlay) will not allow for removal of deck panels for crane access from the surface.
- Will the soil to the top of the medium dense sand be capable of supporting excavation and bracing equipment without remedial work? If not, the estimate should cover the cost of the remedial work.
- Is the soil at the invert of the station capable of resisting "uplift" or "boil" to allow placement of the invert slab or is remedial soil stabilization required.
- Be sure to provide vertical access through the station and the temporary decking for hoisting materials and permanent equipment (i.e. large fans, etc.)
- Sheet 13 shows the final roadway of 4 lanes which is 2 less that the current configuration of 4 plus a dedicated turning lane and a bus lane. Is this desirable?
- The drawings indicate that slurry walls will be used on both sides of 4th Ave. The schedule indicates a slurry wall for the west side of 4th and a secant pile wall will be used on the east side of 4th Ave. Secant piles at 180 feet with a 5% tolerance could end up having a 14-foot gap at the lower end if two adjacent piles were within tolerance but deviate in the opposite direction. If

the ground is "iffy" (a technical term for potentially problematic – water bearing, loose, flowing, etc.), consider using a slurry wall instead of secant piles.

CID 4th Ave Shallow

- The Mid-town Station appears to require a lot of ground improvement.
    - What type and what is the access for the installation of the improvement
    - What is the construction methodology for the station? SEM?
    - Please explain the purple cross-hatched area between 3rd & 6th and Union & Seneca.
- Is the tunnel from SB-S 72+00 to 91+00 to be by SEM? If so, make sure the design and estimate reflect the very loose material in this area.

CID 4th Ave Shallower with 1200' of SEM tunnel north to the Mid-Town Station

- Where will the TBMs be removed? At the Mid-town Station or at the southern SEM portal? If at the southern SEM portal, assure that the schedule reflects a delay in the interior SEM tunnel finishes until after the TBMs have been removed.
- For the SEM tunnel, bring the track centers closer together from south of the Mid-town Station to immediately before the CID station to reduce the width / height of the SEM Excavation. Use the Bellevue SEM tunnel section in lieu of twin tunnels.
- Narrow the trackway centers after the CID station to reduce the width of the cut and cover section.
- If SEM is to be used, much more geotechnical investigation is required in comparison to a TBM tunnel. Beacon Hill Station is a good example. A lot of pre-bid and post-bid / pre-construction exploration was done, but we still had a nasty surprise with a massive amount of water bearing clean sand which would flow under 1 inch of water head (the insitu water head was 30+ feet).

North of CID – East of 3rd Ave

- Is SEM anticipated to construct the station platform between the 2 access shafts and the cross-over to the north of the northern shaft? If so, then a large staging area will be needed to support this activity. The 1-acre site at Beacon Hill was very tight.
- Could the undeveloped lot be acquired as a construction staging site?
- Is a single connection to the PSS sufficient, or should there be a second connection in case of maintenance or emergency requirements?

North of CID – East of 4th

- It appears as if the BNSF tunnel is close to and above the station and cross-over. Even with the best construction technique some settlement will occur which could potentially impact the BNSF tunnel. This may not be the best alignment due to the potential settlement impact on the BNSF Tunnel.
- Could the undeveloped lot be acquired as a construction staging site?
- Is a single connection to the PSS sufficient, or should there be a second connection in case of maintenance or emergency requirements?
- Based on the "PSQ 45 Pioneer 45 Draft Conceptual Construction Schedule 121222" the entire station and 100 feet of the crossover will be constructed by cut and cover methods and the

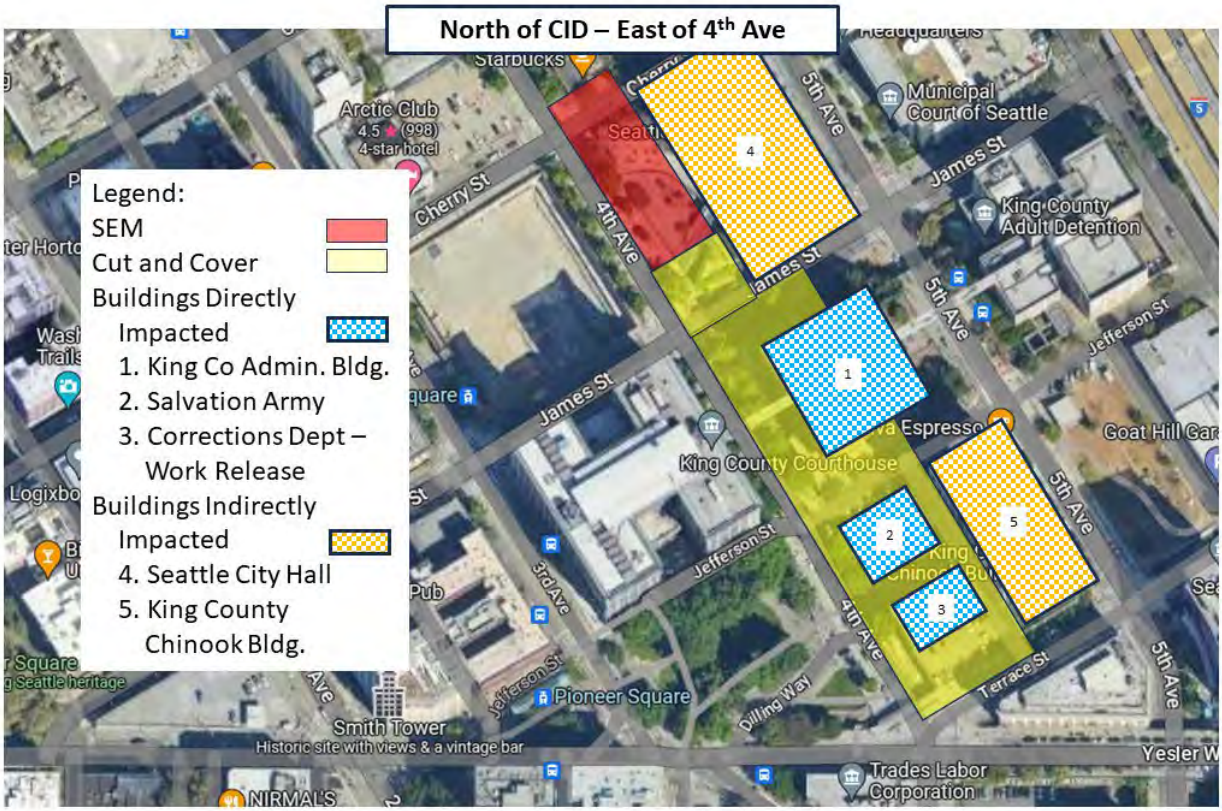
remaining 300 feet of the cross-over will be constructed by SEM. The cut and cover will directly impact 3 buildings which must be demolished:

1. The King County Administrative Building
2. The Crouley Building (currently occupied by the Salvation Army Jefferson Day Care)
3. The Corrections Department – Work Release Building

It will indirectly, but significantly, impact 2 other buildings:

4. Seattle City Hall
5. King County Chinook Building.

The ownership of these buildings may make this option politically unacceptable.



- If acceptable, the schedule provided doesn't anticipate any time for the demolition of the buildings, therefore, I assume that an advanced demolition contract has been anticipated.
- With the demolition of the King County Administrative Building there is a marginally acceptable staging area for the work anticipated (0.91 aces vs 1.18 acres at Beacon Hill).
- In lieu of closing James completely for 4+ years as shown on the graphic schedule, it might be preferable to deck over the James St cut and cover excavation to keep James St open. Allow excavation and other work on a 12 hour / day basis from 6 PM to 6 AM with hoisting through removable deck panels. This avoids impacting traffic. The Contractor avoids traffic impacts to the construction haul. Nighttime noise should not be an issue given the nature of the

surrounding business activities. For installation of the decking only, close the street and detour the traffic for about 1 month and allow 24/7 work during this period.

- Allow early start of structural construction in the station by blocking out the invert to slide the TBMs through as done at Beacon Hill. Infill the invert after the TBMs have been pushed through and relaunched.
- Secant piles at 105 feet with a 5% tolerance could end up having a 6-foot gap at the lower end if two adjacent piles were within tolerance but deviate in the opposite direction. If the ground is "iffy" (a technical term for potentially problematic – water bearing, loose, flowing, etc.), consider using a slurry wall instead of secant piles.
- The graphic schedule and the step by step write up are not in sync with respect to the construction on James St.
- Horizontal jet grouting is shown in 2 locations for preparation of the TBM portals (launch and receiving). I had been previously advised *"If you are considering horizontal jet grouting, use something else, even if it hasn't been invented yet."* Consider a pipe canopy or rebar spiling depending on the ground conditions.
- The Beacon Hill SEM average excavation rate for the platform tunnels (36'W x 32'H) was 0.90ft per day. If the crossover were the same size, it would take approximately 15 months to excavate, not the 12 as shown on the schedule. However, the crossover tunnel is almost 3 times larger than the Beacon Hill platform tunnels. If the rate were ½ that of Beacon Hill or 0.45 ft per day, a more realistic duration would be more than 27 months.
- Schedule activity 7.23 shows the excavation and temporary support of the James St decking on blocks. Schedule activity 8.26 appears to show the same section supporting active traffic while the other side of the road is being excavated, the deck installed and connected to the temporally supported deck. This is very risky due to the potential for the soil to settle / consolidate under the blocks with traffic loading.

South of CID 6th – North of Royal Brougham

- Could the alignment be pushed west to be under 6th Ave to avoid going under the buildings east of 6th Ave.?

4th Shallow Refined Draft Conceptual Construction Schedule 221128

- The schedule indicates that slurry walls will be used on the west side of 4th Ave and a secant pile wall will be used on the east side of 4th Ave. Secant piles at 180 feet with a 5% tolerance could end up having a 14-foot gap at the lower end if two adjacent piles were within tolerance but deviate in the opposite direction. If the ground is "iffy" (a technical term for potentially problematic – water bearing, loose, flowing, etc.), consider using a slurry wall instead of secant piles.
- The schedule seems to indicate that the parking garages on the east side of 4th Ave. (PMI and Sound Transit) would be closed from July 2025 through November 2030, a period of 5 ½ years. Who is going to pay for lost revenue for PMI? Where are the ST vehicles and other POVs that have been provided parking in the ST garage going to be housed during this period?
- The schedule indicates that the permanent roadway deck will be constructed before the station box is excavated. Be sure to provide vertical access through the permanent roadway and station for hoisting materials and permanent equipment (i.e. large fans, etc.)

- Some activities seem to be very aggressive with respect to production:
    - Activity 62 - 40' Bents @ 4 d/ea
    - Activity 63 - Deck Spans @ 6 d/ea
    - Activity 64 - Excavation under deck @ 500 cy/d
- It seems as if there might be a disconnect between:
    - Activity 83 "Excavate TBM Retrieval Pit at Main Street & 4th Ave" >.08/06/31- 10/14/31 and
    - Activity 121 "TBM Retrieval at Main Street" > 09/01/30 – 01/03/31

  Where the TBM retrieval is occurring before the excavation of the retrieval pit.

PPT: "CID Dave Peters Comments"

- Slide 5 shows that traffic will be detoured onto:
    - N-S streets: 1st, 6th and Maynard
    - E-W streets: Yesler, S. Washington, S. Jackson and Royal Brougham

  These streets are already narrow and congested and used heavily during events at the 2 stadiums. Dumping more traffic onto them for a significant number of years is not realistic. Also, when the CID and the City are advised of the traffic impacts within the CID and elsewhere for a significant number of years, a station on 6th at S. Jackson St. might look more appealing > shorter term local impacts vs. long term "regional" impacts.

- Case 4 "Station and Tracks at Grade": If the mezzanine is below the track level, consider using side platforms to reduce the track centers and narrow the excavation both north and south of the station.

Gall Zeidler Consultants
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MEMORANDUM

2471 MEM001 R00 Dr.doc

To: R. Stewart / Value Management Strategies, Inc. (VMS)

From: D. Reda / Gall Zeidler Consultants, LLC (GZ)

Cc: W. Klary / Gall Zeidler Consultants, LLC (GZ)

Subject: Key Issues Memorandum – Case 1 & Case 2

Reference: CID 4th Avenue Dave Peters Response 20221212

Date: August 10, 2023

Dear Mr. Stewart,

After reviewing the presentation on CID 4th Avenue Case 1 and Case 2 alternatives to the DEIS proposal, I have the provided observations and alternatives herein. My observations on these cases are viewed with the following supplemental information (please note that I was not provided to the Sound Transit Sharepoint site for the full depth of information):

- 4th Shallow Refined Draft Conceptual Construction Schedule 221128.pdf
- 4th Shallower CID with Mez over DSTT and 1200' SEM Tunnel to North to Midtown Station.pdf
- CID 4th Shallow Downtown-SODO.pdf
- CID North East of 4th and East of 3rd.pdf
- CID South 6th Ave S north of RB.pdf
- Conceptual Architectural Layout CID North PSQ 35.pdf
- Conceptual Architectural Layout CID North PSQ 45.pdf
- Conceptual Architectural Layout CID South 221121.pdf
- EWG 75 4th Shallow Construction Staging Concept 20220107 (with page number).pdf

In addition to the above, I referenced the below geologic section that was available when reviewing the Single Bore Option at CID Station. Please note that this geologic was along 5th Avenue from mid-2018.

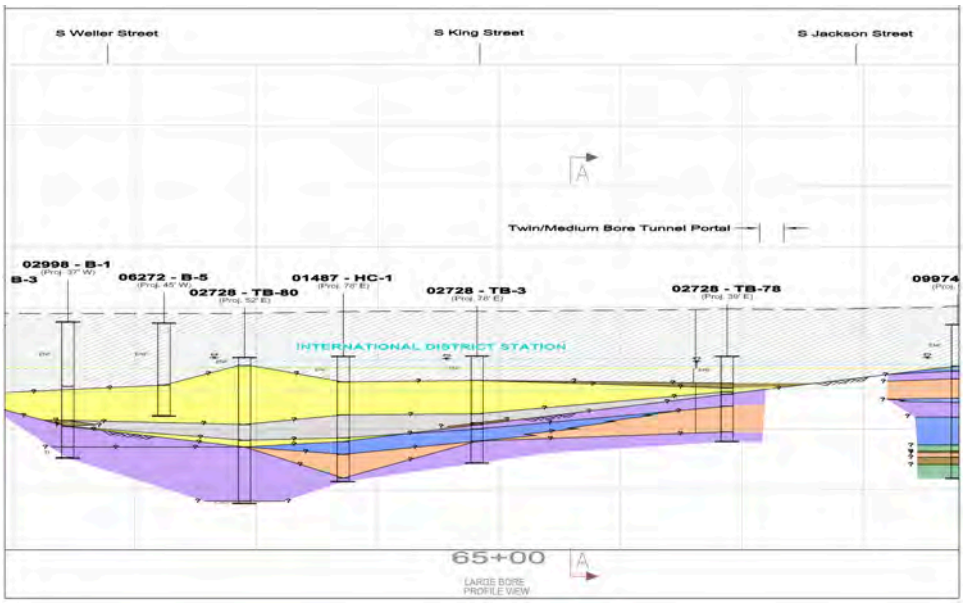


Figure 1: Geologic Profile along 5th Avenue (dated mid-2018)

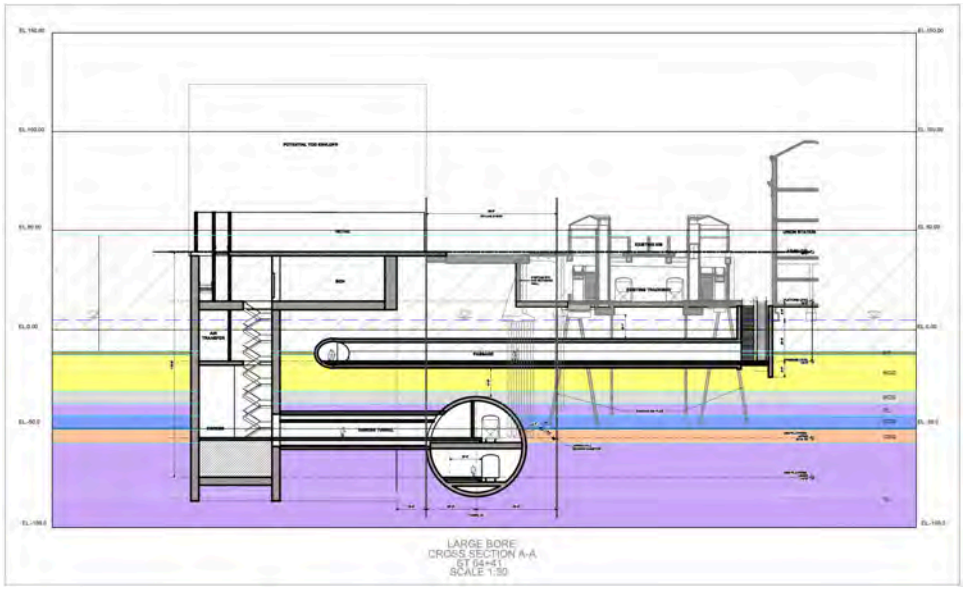


Figure 2: Section A-A from Figure 1 Geologic Profile (dated mid-2018)

Case 1 & Case 2 Initial Observations / Comments / Questions

1. Case 3-5 were eliminated from the review due to being deemed “not practical”
2. No mezzanine was shown, but was referenced elsewhere in the presentation (assumed mined tunnels under to Union & Sounder Stations)
3. Can the WSBLE track vertical alignment be adjusted to suit the ~55-ft difference to platform level from the DEIS?
4. Why is the distance of slurry wall to BNSF a challenge? (it is equivalent to DEIS)
5. Will slurry walls / secant pile walls be deeper than DEIS?
6. What are the staging areas for this work?
7. Case 2 specific:
    a. Will permanent viaduct columns (mid viaduct support) still be required?
    b. What is the available working height underneath the viaduct?
    c. What is the c/c distance between viaduct supports (in-plane & out-of-plane)

d. Any consideration for demolition of the outer wings of the viaduct to enable larger slurry equipment? (Replaced after slurry walls are in place)

Supplemental Information considered in the Evaluation

The below figures are from the CIRIA report C760 - Guidance on embedded retaining wall design, which show horizontal and vertical ground surface movements behind walls embedded in competent ground (stiff clay).

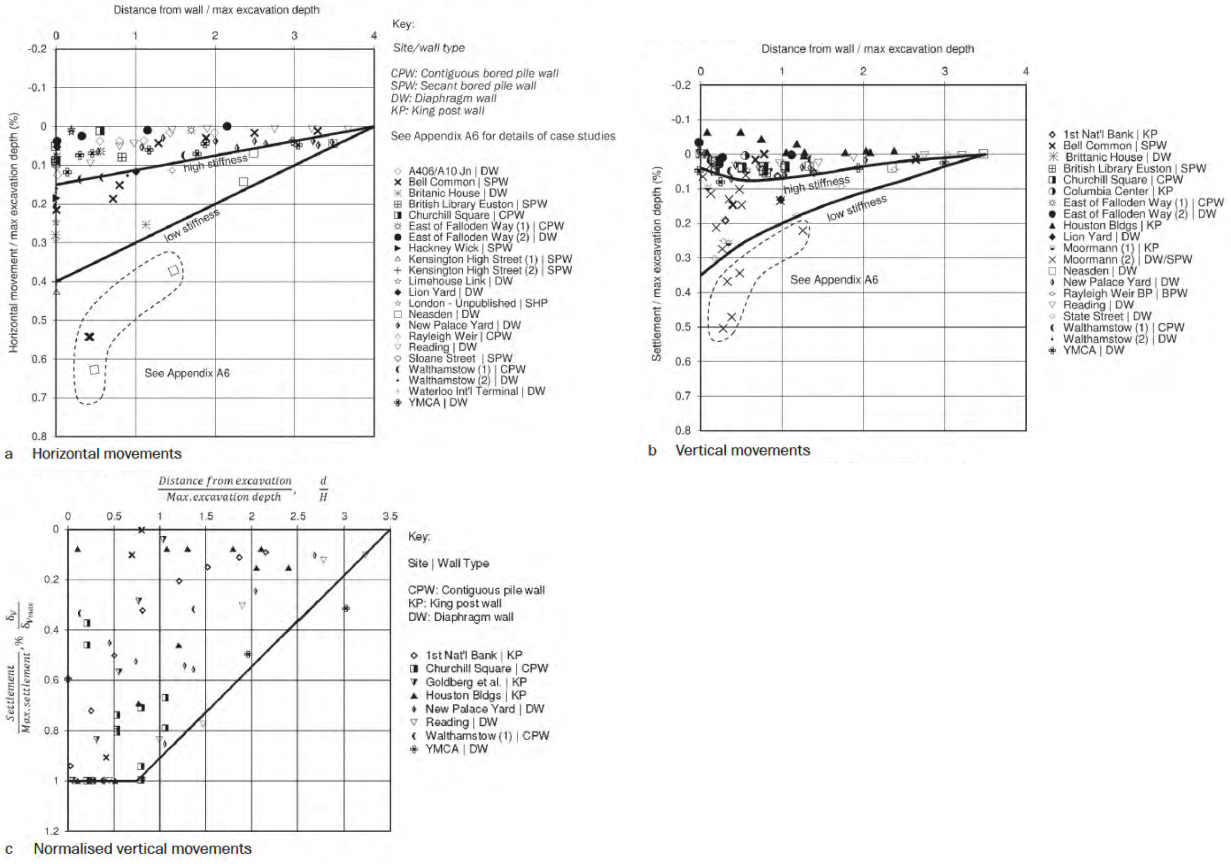


Figure 6.15 Ground surface movements due to excavation in front of wall em

The below table, also from CIRIA report C760, summarizes the magnitude and extent of the monitored ground surface movements due to excavation in front of bored pile, diaphragm and sheet pile walls wholly embedded in competent ground (stiff clay) under conditions of good workmanship. The case study data is related to excavations that range in depth from 8 m (26-ft) to 31 m (102-ft).

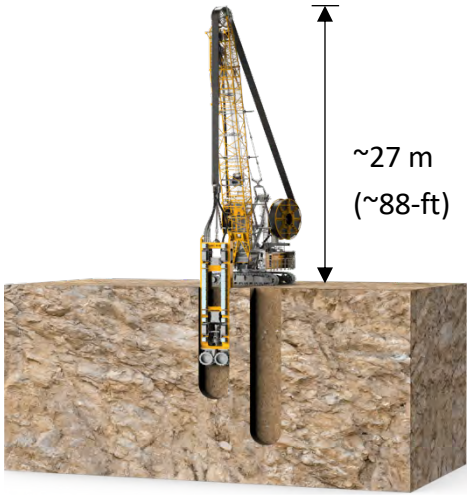
Table 6.3 Ground surface movements due to excavation in front of bored pile, diaphragm wall and sheet pile walls wholly embedded in competent ground (stiff clays)

Movement type	High support stiffness (high propped wall, top-down construction)		Low support stiffness (cantilever or low-stiffness temporary props or temporary props installed at low level)	
	Surface movement at wall (per cent of max excavation depth)	*Distance behind wall to negligible movement (multiple of max excavation depth)*	*Surface movement at wall (per cent of max excavation depth)*	*Distance behind wall to negligible movement (multiple of max excavation depth)*
Horizontal	0.15	4	0.4	4
Vertical	0.1	3.5	0.35	3.5

Notes

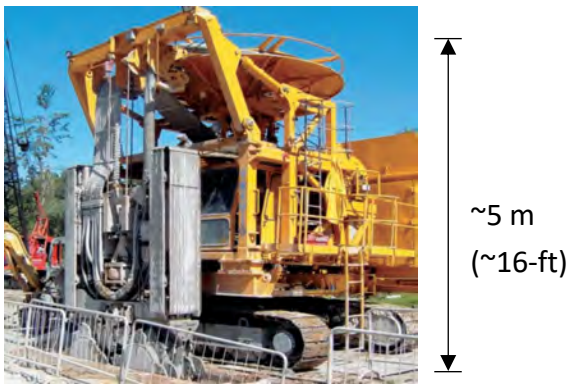
1 Maximum surface movement occurs close to the wall and is expressed as a percentage of maximum excavation depth in front of the wall.
2 Extent of movement is calculated non-dimensionally by dividing by maximum excavation depth.
3 Movements exclude those arising from wall installation effects.
4 Movements are for good workmanship and walls wholly embedded in stiff clays, retaining stiff clays or other competent soils.
5 Movements will be greater where soft soils are encountered at formation level (see Figure 6.14 and Appendix A6).

The below graphics are for typical slurry wall equipment.



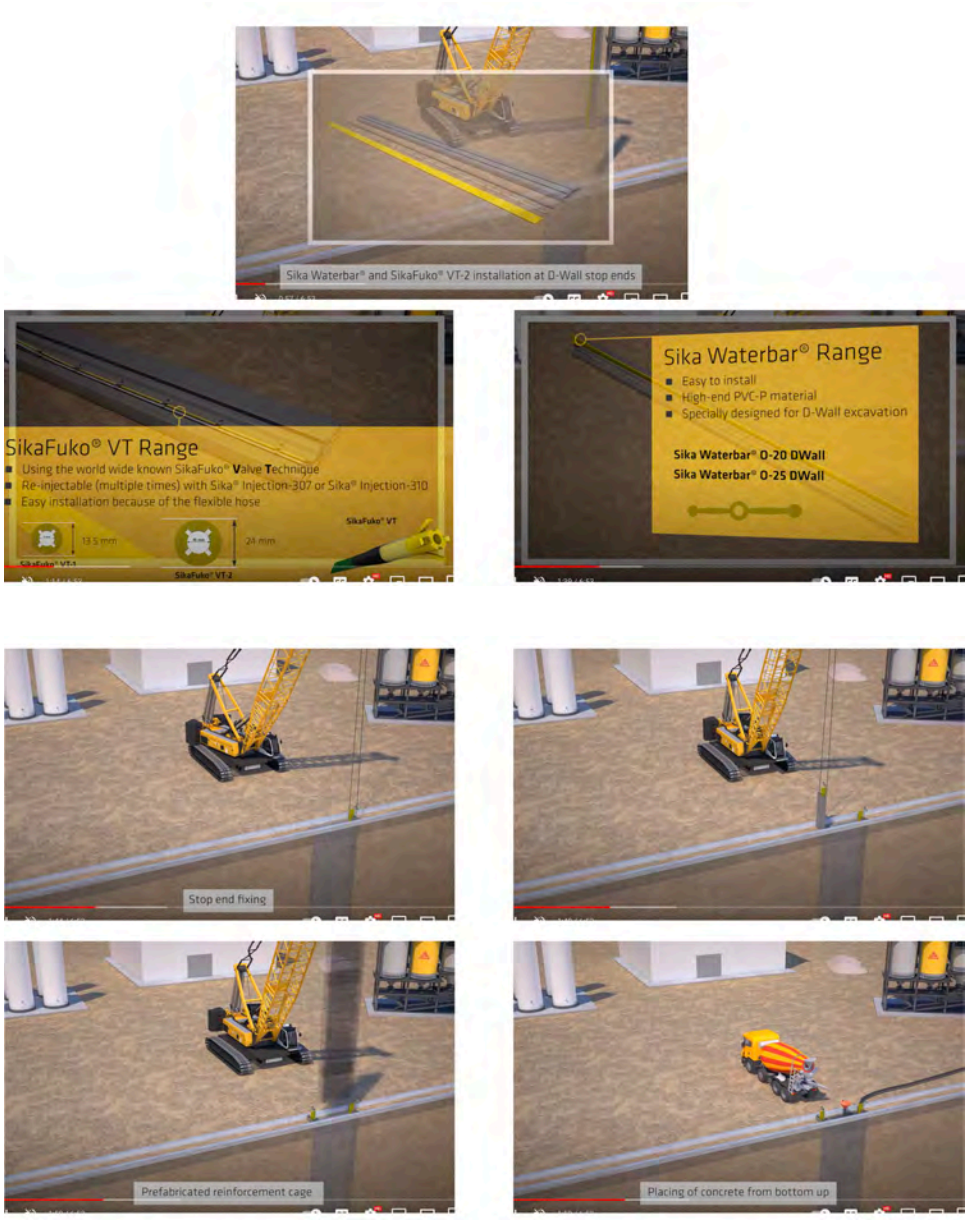
Source: https://www.liebherr.com/en/int/products/construction-machines/deep-foundation/methods/slurry-wall-production/hydromill-cutter/hydromill-cutter.html

Compact Options for Low Headroom



Source: https://www.ecanet.com/uploads/files/Resources/BC_Trench_Cutter_Systems_EN_905_679_2.pdf

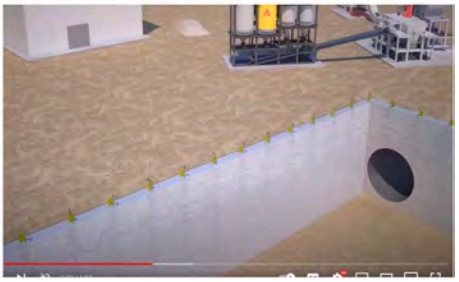
Joint treatment for the slurry wall options will be a challenge and risk seepage into the station long-term. There are systems in place (e.g. Sika) to provide waterproofing solutions, with repair opportunity built in. Below are a few graphics (courtesy of Sika) to represent what mitigations can be put in place.




p ends - Sika Waterbar® and SikaFuko® VT-2 remain in the panel

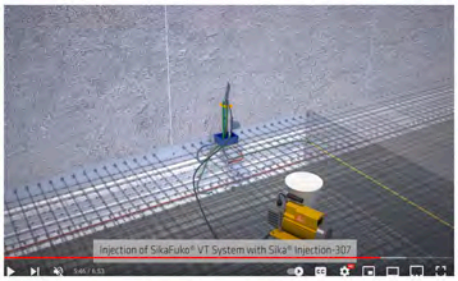


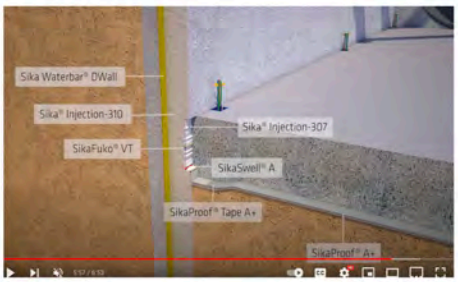

Need to review
protection of waterstop
when Hydromilling



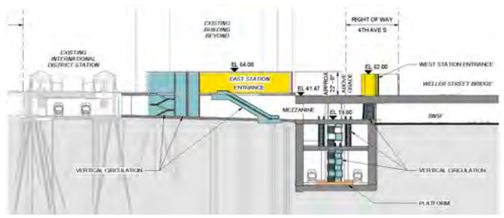
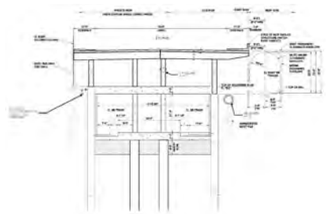
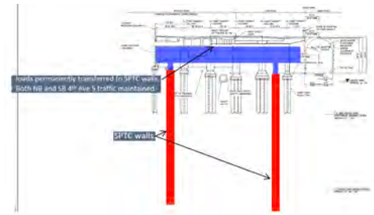

SikaSwell® Range
Easy to install
Able to swell into cracks and gaps
Function tested up to 10 bar
Tested for long-term durability
SikaSwell® S-2
SikaSwell® A

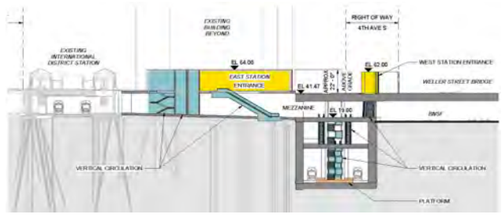
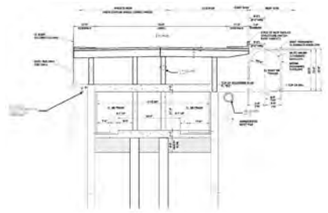
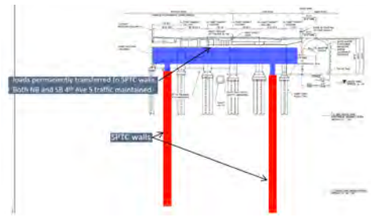

Concreting base slab and installation of SikaFuko® VT System in the construction joints


Injection of SikaFuko® VT System with Sika® Injection-307


Sika Waterbar® DWall
Sika® Injection-310
Sika® Injection-307
SikaFuko® VT
SikaSwell® A
SikaProof® Tape A+
SikaProof® A+

Evaluation of Concepts

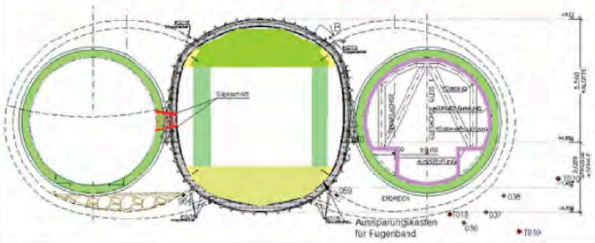
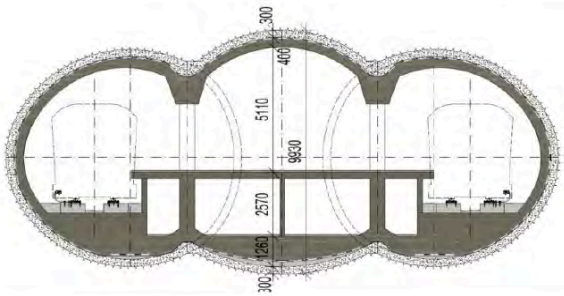
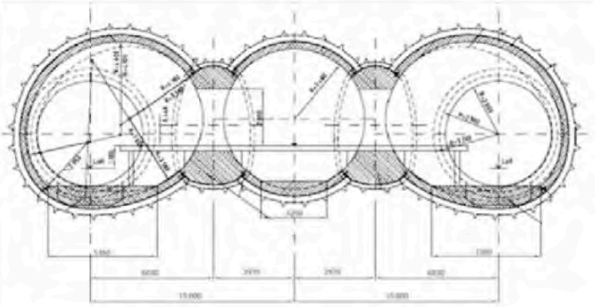
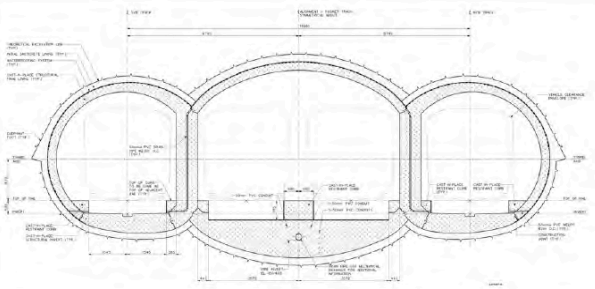
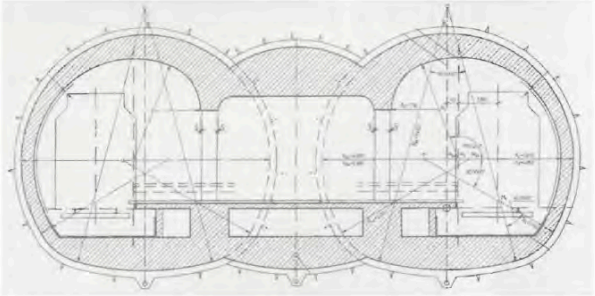
KIM Topic	Case 0 DEIS 4th Ave Shallow Summary	Case 1 Top-Down Construction with New Viaduct	Case 2 Top-Down Construction with Existing Viaduct
General Overview			
Platform Depth	approx. 80 ft	approx. 25 ft	approx. 25 ft
Portal Location	Portal location S. Main Street	(assumed the same) Not provided in reviewed information	(assumed the same) Not provided in reviewed information
Construction Overview	- Staged construction maintaining two lanes of traffic, stage west and east - Temporary viaduct during construction replaced with permanent viaduct at end of construction, stage west and east	- Staged construction maintaining two lanes of traffic (assumed), stage east and west - Temporary viaduct during construction replaced with permanent viaduct at end of construction, stage west and east	- Similar to Case 1, however, existing viaduct remains; loads are transferred to permanent station slurry walls
Construction Staging	Phase 1 - Demo west portion of existing viaduct - Install west slurry wall Phase 2 - Install temporary steel bent - Construct temporary PS concrete deck - Construct temporary railing Phase 3 - Demo east portion of existing viaduct - Install slurry wall Phase 4 - Install temporary steel bent - Construct temporary PS concrete deck - Demo temporary middle pile - Restore traffic on 4th Phase 5 - Excavate below temporary bridge - Install temporary struts as excavation proceeds Phase 6 - Construct mezzanine and station platform - Construct permanent viaduct	Phase 1 - Demo east portion of existing viaduct - Install east slurry wall (perm station wall) - Install perm viaduct columns (mid viaduct support) Phase 2 - Install east side viaduct (perm road) Phase 3 - Demo west portion of existing viaduct - Install west slurry wall (perm station wall) - Install perm viaduct columns (mid viaduct support) Phase 4 - Install west side viaduct (perm road) Phase 5 - Excavate below perm viaduct - Install temporary struts as excavation proceeds Phase 6 - Construct station platform - Transfer load of viaduct columns (mid viaduct support) to permanent station walls / columns	(Assumed) Phase 1 - Install east slurry wall (perm station wall) - Install west slurry wall (perm station wall) support) Phase 1b (???) - Install perm viaduct columns (mid viaduct) - Install east side viaduct (perm road) Phase 2 - Install viaduct load transfer support structure - Transfer viaduct loads to east/west slurry walls Phase 4 - Excavate below perm viaduct - Install temporary struts as excavation proceeds Phase 6 - Construct station platform - Transfer load of viaduct columns (mid viaduct support) to permanent station walls / columns (as required)

KIM Topic	Case 0 DEIS 4th Ave Shallow Summary	Case 1 Top-Down Construction with New Viaduct	Case 2 Top-Down Construction with Existing Viaduct
General Overview			
Construction Interface Between Contracts	Not provided in reviewed information	Not provided in reviewed information	Not provided in reviewed information
Traffic Control / Maintenance	Temporary diversions for partial and full road closures for at least 6 years	Temporary diversions of traffic (east/west) until new viaduct is in place	No interruption of 4thAvenue traffic
Schedule	9 to 11 Years	duration is <9 to 11 (unclear how long)	- duration is <9 to 11 (unclear how long) - Low headroom equipment and construction operations adds 3+ years to schedule (assumed 3+ years vs. Case 1)
Specifications	N/A	N/A	N/A
Risk Register	- Cross under DSTT - Demo adjacent to BNSF Tracks (protective measures needed	- leakage / seepage through permanent slurry wall - The distance to the Condo Building façade and BNSF track need to be checked for slurry wall equipment assumptions. - Check swing of crane with rebar changes (over viaduct and over BNSF track / near condo building)	- See also Case 1 comments
Cost Estimate	Total Cost not provided in reviewed information	Total Cost / Saving not provided in reviewed information	Total Cost / Saving not provided in reviewed information (increased cost vs Case 1 due to low headroom slurry equipment)

Alternative Concepts for 4th Ave Station – Mined Alternative

The below mined vaulted options were presented in the ACE Report for the Downtown Segment of WSBLE. The concept could be used to reduce the length of C&C option presented in the DEIS for 4th Ave Station.

Table 4-2. Summary of Multi-Cell Underground Structures

Project Name	Cross Section
U5 Metro Line – Museum Island Station	
Prague Metro: Veleslavin Station	
Budapest Metro: Gellert Station	
Toronto Transit Commission: Toronto-York Spadina Subway Extension	
Stadtbahn: Dortmund Station	

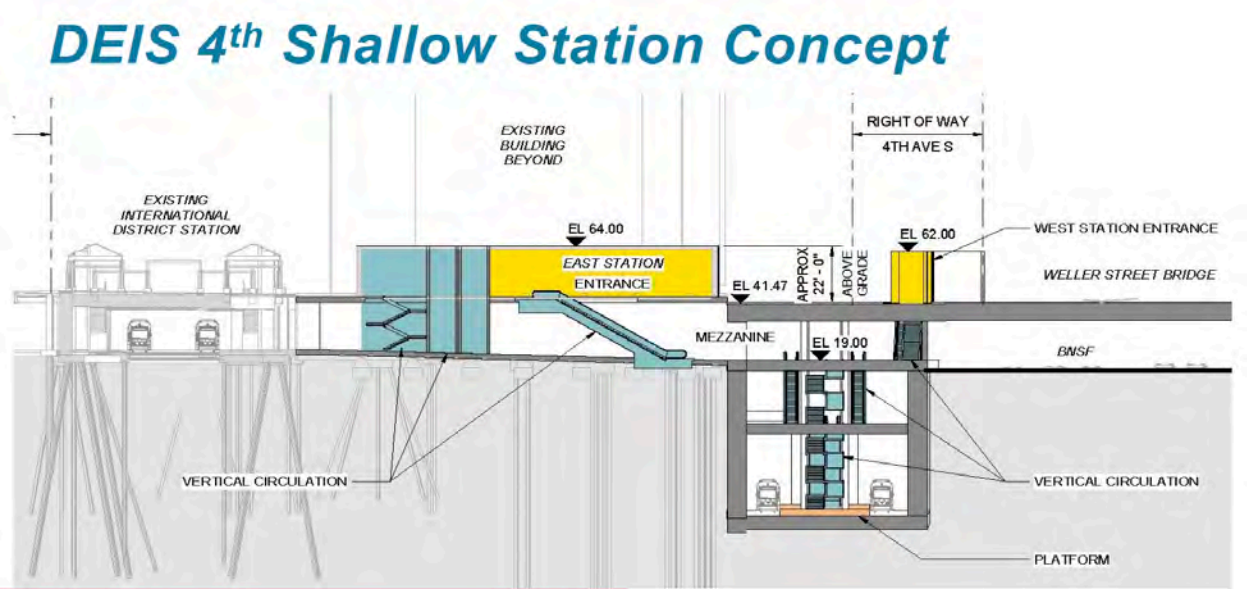
Using the DEIS 4th Ave Station as a baseline, a triple vault option based on Prague Metro: Veleslavin Station is as follows:

OVERVIEW

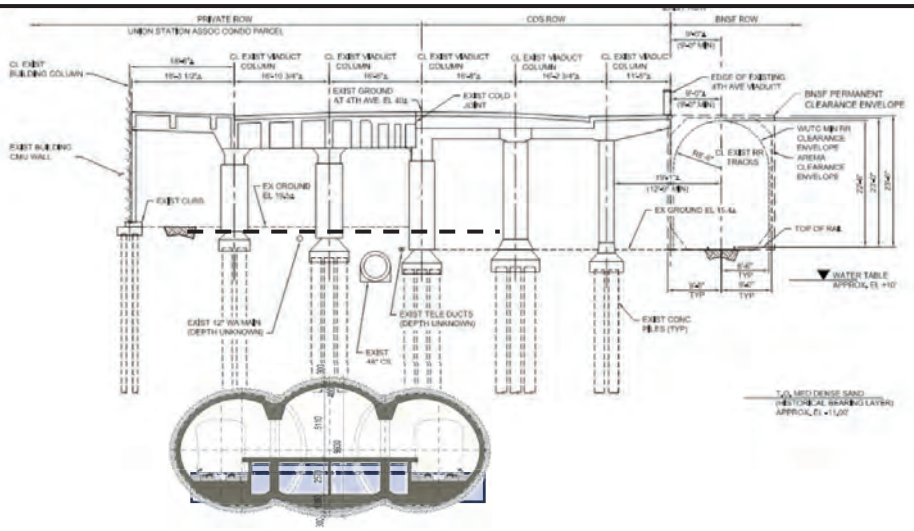
1. Maintain DEIS Concept at transfer location for Union & Sounder Stations
2. Maintain DEIS Platform Depth
3. SEM Mined tunneling in each direction to complete station
    a. Concepts from U5 Metro Line - Museum Island Station and Budapest Metro: Gellert Station are also applicable and may provide better options for lining up with Viaduct Columns
4. Existing Viaduct Piles would be integrated into the SEM Initial Lining; Permanent Loads taken by CIP Concrete Columns
5. Twin TBM Tunnels have an opportunity to be driven through this station prior to C&C and/or SEM mined tunneling

CHALLENGES

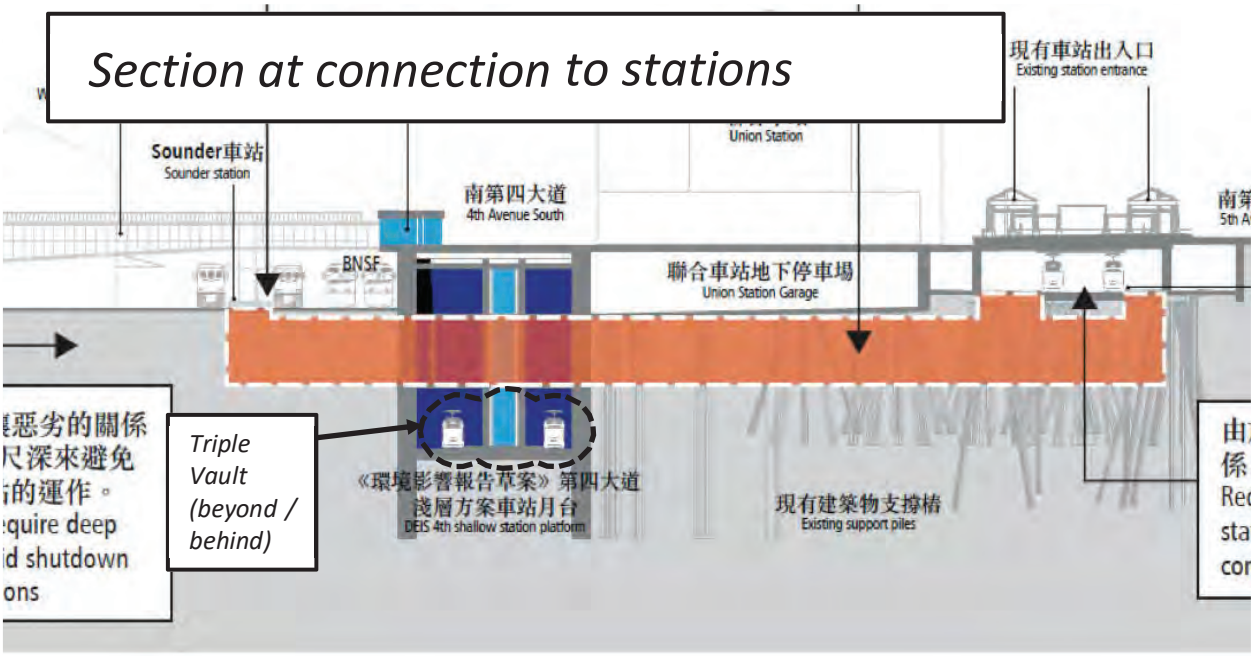
1. Sufficient cover for SEM tunneling; need for pre-support above tunnel crown
2. Settlement of existing viaduct piles
3. Geology would likely require ground improvement
4. Viaduct column support alignment with SEM Columns



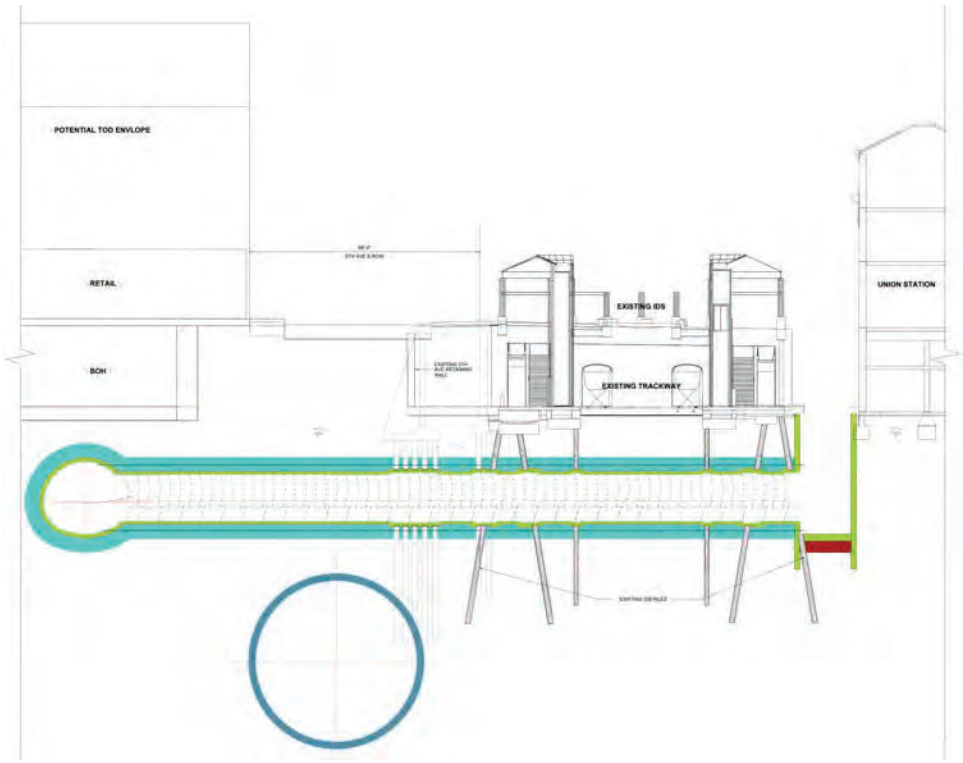
Typical Section of Triple Vault outside of entrances & connection to stations

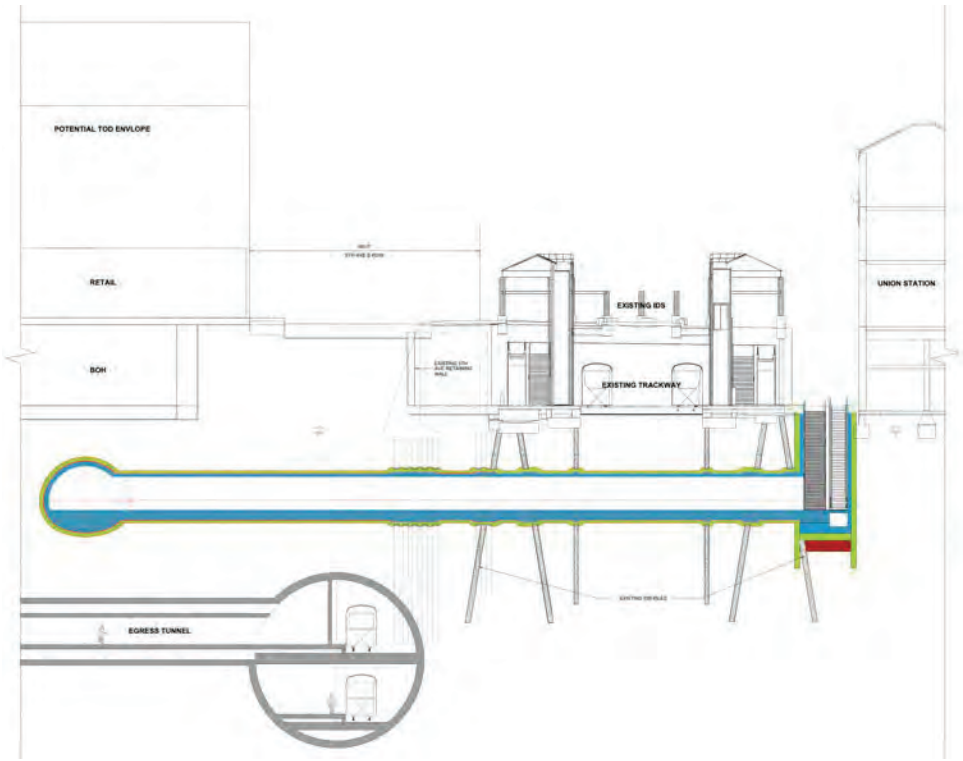


Section at connection to stations

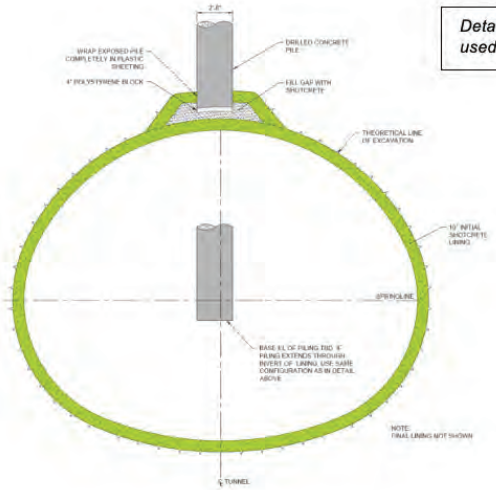


Below are SEM Mined Concepts with Pile integration from the Single Bore Option at CID Station.

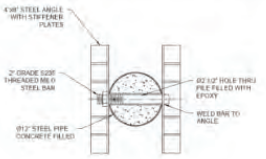




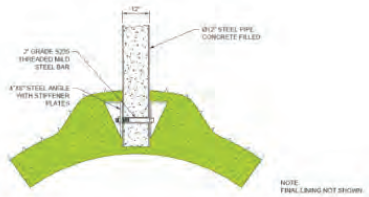
Details are the Ownership of GZ and shall not be used outside of this VE Study without GZ's approval.



A SECTION - TYP INITIAL LINING CONNECTION TO CONCRETE PIERS
SCALE: NONE



PLAN SECTION
SCALE: NONE



B SECTION - AT INITIAL LINING CONNECTION TO STEEL PILING
SCALE: NONE

Alternative Concepts for 4th Ave Station – Pipe Box Alternative

The below Pipe Box option would be based on prior experience with the planning, design and execution of the Sentosa Gateway Road Tunnels. The concept could be used to reduce the length of C&C option presented in the DEIS for 4th Ave Station. It should be noted that a section of the Sentosa Gateway Road Tunnels was constructed over an existing NEL Tunnels in Singapore.

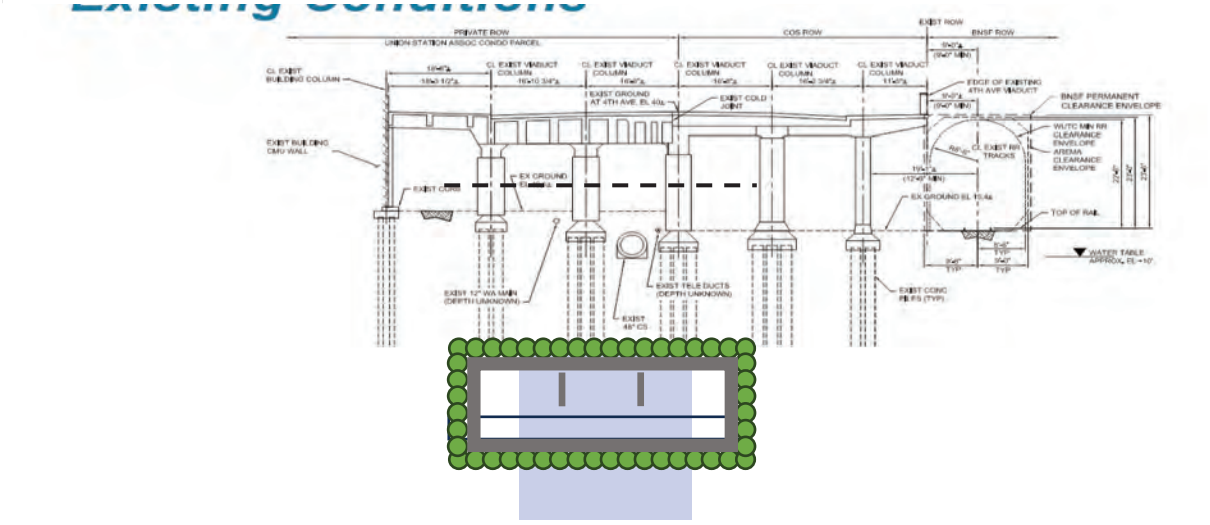
OVERVIEW

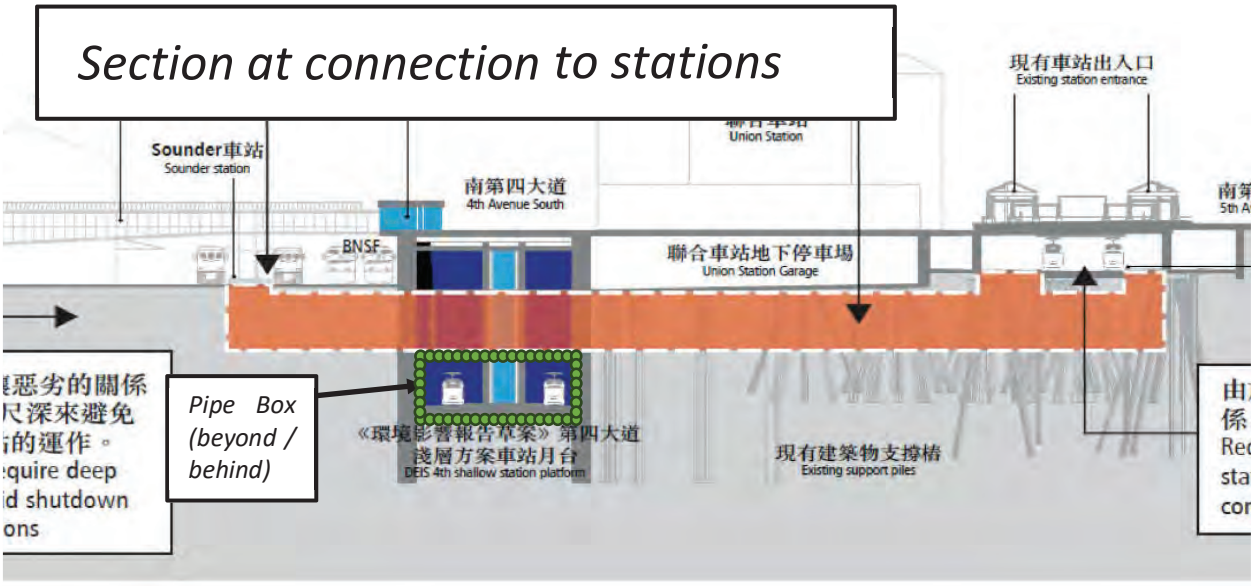
1. Maintain DEIS Concept or Case 1 / Case 2 Concepts at transfer location for Union & Sounder Stations
2. Maintain DEIS Platform Depth
    a. If a shallower tunnel is preferred, this option would like require a slightly deeper tunnel than the Case 1 / Case 2 Concepts
3. Pipe Box tunneling in each direction to complete station
    a. Pipe Box pipes can be reinforced with steel rebar cages over the entire length or where required.
4. Existing Viaduct Piles would be supported by the pipe box structure; Permanent Loads taken by CIP Concrete lining
5. Twin TBM Tunnels *might* have an opportunity to be driven through this station prior to C&C and/or Pipe Box tunneling

CHALLENGES

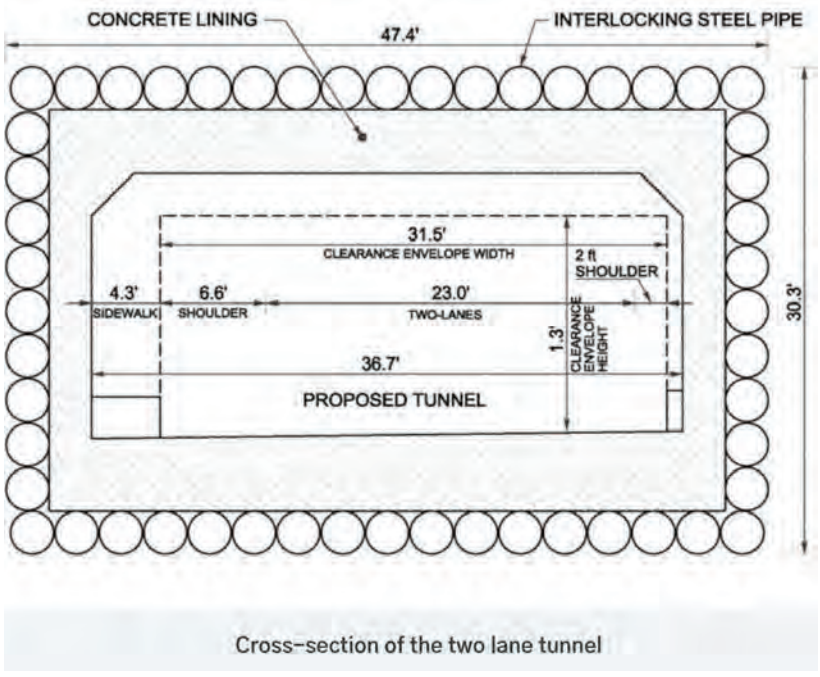
1. Uncertainty to depth of piles; cutting through ends of piles would cause vibration
    a. Need to check if piles steel reinforced
2. Settlement of existing viaduct piles
3. Damage from vibration due to drilling (limited, but needs to be checked)

Typical Section of Pipe Box outside of entrances & connection to stations





Below are Pipe Box experience from Sentosa Gateway Road Tunnels (information is the Ownership of GZ and shall not be used outside of this VE Study without GZ's permission).



Cross-section of the two lane tunnel



Figure 5: Atlas Copco Interlocking Pipes Installed

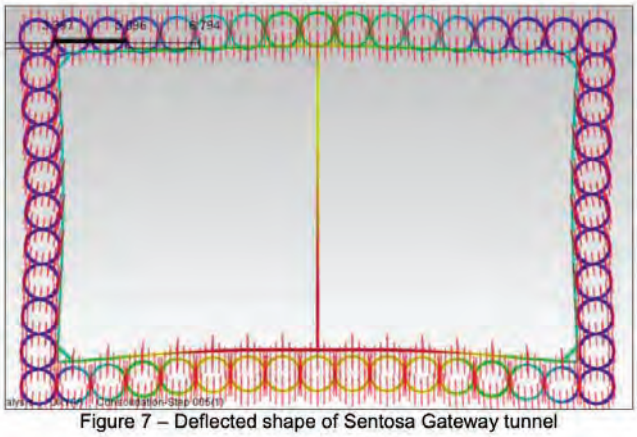


Figure 7 – Deflected shape of Sentosa Gateway tunnel

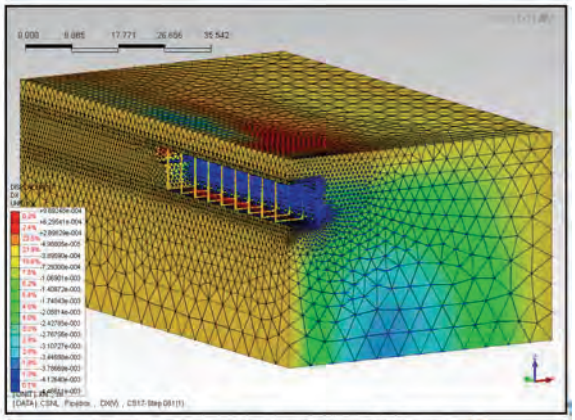


Figure 4: Contour of horizontal ground deformations

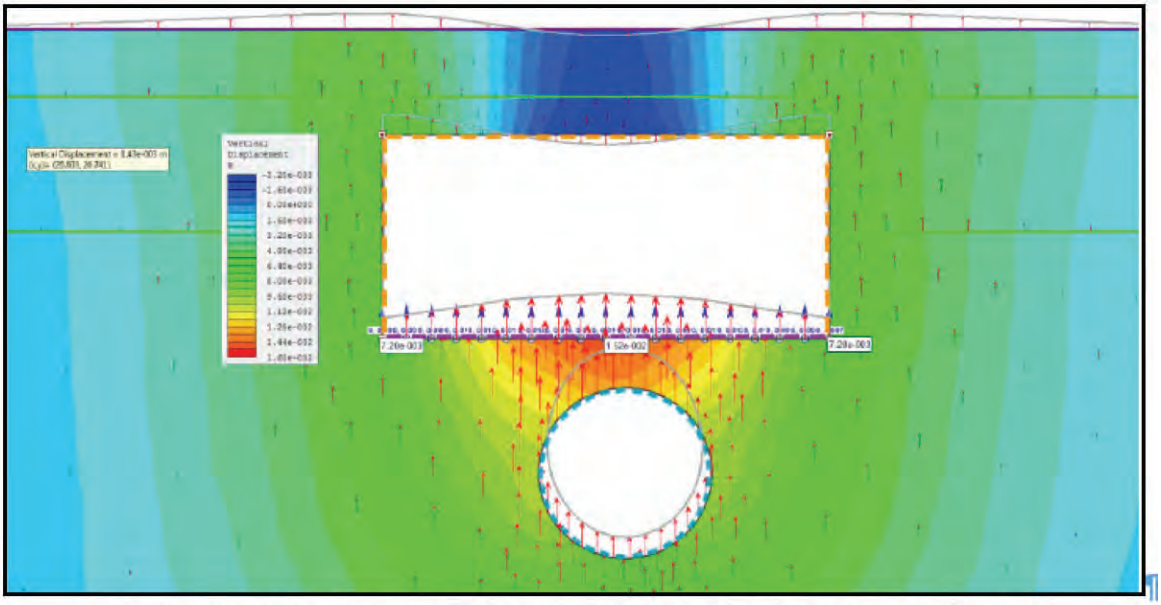


Figure 12: Vertical displacement at existing NEL tunnels Section 3-3

KEY ISSUES MEMORANDUM

TO: Robert Stewart

FROM: Robert “Red” Robinson

DATE: August 8, 2023


21-1-30047-300.327 Profile-_KAP303 202:


Disagreement with rail company leaves

Robert,

My role in this group will be primarily that of providing geotechnical information regarding existing ground conditions. There are several issues that jump out at me, which I will discuss briefly below.

1) I’ve attached a geologic profile that we prepared in the vicinity of the proposed 4th Ave Alignment based on borings drilled for advanced conceptual level design and other existing borings. To the north of about Washington St. the soils beneath a surficial 0 to 20 ft layer of fill, generally consist of very dense or hard glacially overridden soils including glacial till, hard clay, and very dense sand, gravel and silt. However, south of about Washington St. the soils consist of 20 feet to over 100 feet of loose to medium dense silt and sand granular fill and soft to stiff silty clay to clayey silt. The fill in this southern portion of the alignment was dumped or pumped into tidal flats between the late 1800s and early 1900s. These fill soils do not provide sufficient support for most buildings, highway and rail structures and therefore most buildings and any elevated roads are supported on pile foundations that extend down and into the dense/hard glacially overridden soils.
2) Red and orange vertical lines on several of the borings identify portions of the fill and native post-glacial soils that we have identified as being potentially liquefiable during a significant earthquake. The last significant earthquake in 2021 resulted in liquefaction of post glacial sand layers beneath much of the International District, SODO District and Boeing Field areas, resulting in sand “volcanoes” or “boils” in which the liquefied sand and silt extruded from the ground at localized locations resulting in settlement of the overlying soil and structures.
3) A recent newspaper article noted that the 14 year old light rail tracks in the Industrial and SODO Districts (east side of the stadiums) have settled by up to 3 inches, and will require partial shutdowns for realignment. These tracks are located on the fill soils which continue to consolidate and settle over time. Access to the ground will be needed to construct a “shallow” 4th Ave South Station and cut and cover track alignment.
4) A June 17, 2022 Times article ago noted that the Union Pacific Railroad would not allow the city to access the Argo rail yard beneath the 4th Ave S. Bridge (south of the West Seattle/Spokane St. elevated roadway). Similar challenges may occur with accessing ground beneath the 4th Ave. S. elevated structure between King St. Station and to the south, which is currently immediately adjacent to active railroad tracks.